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# TYPICAL CITATION AND ABSTRACT

Analytical aerodynamic models are derived from a high alpha 6 DOF wind tunnel model. One detail model requires some interpolation between nonlinear functions of alpha. One analytical model requires no interpolation and as such is a completely continuous model. Flight path optimization is conducted on the basic maneuvers: half-loop, 90 degree pitch-up, and level turn. The optimal control analysis uses the derived analytical model in the equations of motion and is based on both moment and force equations. The maximum principle solution for the half-loop is poststall trajectory performing the half-loop in 13.6 seconds. The agility induced by thrust vectoring capability provided a minimum effect on reducing the maneuver time. By means of thrust vectoring control the 90 degrees pitch-up maneuver can be executed in a small place over a short time interval. The agility capability of thrust vectoring is quite beneficial for pitch-up maneuvers. The level turn results are based currently on only outer layer solutions of singular pertrubation. Poststall solutions provide high turn rates but generate higher losses of energy than that of classical sustained solutions.

Author

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# Scientific and Technical Aerospace Reports

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## 01 AERONAUTICS (GENERAL)

**N91-16988#** Transportation Research Board, Washington, DC.
**PUBLIC-SECTOR AVIATION ISSUES: GRADUATE RESEARCH AWARD PAPERS Transportation Research Record, 1988 - 1989**
1990 66 p Sponsored by FAA
(PB91-108415; TRB/TRR-1257; LC-90-41736;
ISBN-0-309-05012-X) Avail: NTIS HC/MF A04 CSCL 01B

The main subject areas covered are: land use control and policy for airport development; general aviation safety; where can safety improvements be made; cockpit-crew crisis decision making; robust tracking and control strategies for automatic landing systems; and empirical analysis of runway occupancy with applications to exit taxiway location and automated exit guidance. Author

**N91-16989#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Systems and Logistics.
**PRODUCTIVITY MEASUREMENT IN AIRCRAFT MAINTENANCE ORGANIZATIONS M.S. Thesis**
Billy J. Gililland Sep. 1990 224 p
(AD-A229239; AFIT/GLM/LSM/90S-20) Avail: NTIS HC/MF A10 CSCL 15/5

This research was undertaken to explore productivity measurement in aircraft maintenance units and to examine the relationships of the measures used to evaluate a unit's productivity. Review of current literature and regulatory guidance concerning productivity measurement provided the basis for the development of an interview questionnaire. A questionnaire was administered to Deputy Commanders for Maintenance (DCMs) and chiefs of analysis at ten Military Airlift Command (MAC) wings. Additionally, managers in the maintenance management, cost and manpower divisions at Headquarters MAC were interviewed. From these interviews, information concerning current productivity measurement methodology was gathered and thirteen measures were identified for analysis. Of the thirteen measures evaluated, eight produced the strongest explainable model reflecting maintenance productivity. Manhours per flying hour was the predominant output when viewed as a result of the influence of mission capable rates and maintenance scheduling effectiveness. Cannibalization rates, delayed discrepancies (both awaiting parts and awaiting maintenance) and the average number of aircraft possessed were the inputs which appeared to contribute most significantly to mission capable rates and maintenance scheduling effectiveness. GRA

## 02 AERODYNAMICS

Includes aerodynamics of bodies, combinations, wings, rotors, and control surfaces; and internal flow in ducts and turbomachinery.

For related information see also *34 Fluid Mechanics and Heat Transfer.*

**N91-16990*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
**A PARAMETRIC EXPERIMENTAL INVESTIGATION OF A SCRAMJET NOZZLE AT MACH 6 WITH FREON AND ARGON OR AIR USED FOR EXHAUST SIMULATION**
James M. Cubbage (Vigyan Research Associates, Inc., Hampton, VA.) and William J. Monta Washington Feb. 1991 106 p
(NASA-TP-3048; L-16707; NAS 1.60:3048) Avail: NTIS HC/MF A06 CSCL 01A

A parametric experimental investigation of a scramjet nozzle was conducted with a gas mixture used to simulate the scramjet engine exhaust flow at a free-stream Reynolds number of approximately 6.5 x 10(exp 6) per foot. External nozzle surface angles of 16, 20, and 24 deg were tested with a fixed-length ramp and for cowl internal surface angles of 6 and 12 deg. Pressure data on the external nozzle surface were obtained for mixtures of Freon and argon gases with a ratio of specific heats of about 1.23, which matches that of a scramjet exhaust. Forces and moments were determined by integration of the pressure data. Two nozzle configurations were also tested with air used to simulate the exhaust flow. On the external nozzle surface, lift and thrust forces for air exhaust simulation were approximately half of those for Freon-argon exhaust simulation and the pitching moment was approximately a third. These differences were primarily due to the difference in the ratios of specific heats between the two exhaust simulation gases. A 20 deg external surface angle produced the greatest thrust for a 6 deg cowl internal surface angle. A flow fence significantly increased lift and thrust forces over those for the nozzle without a flow fence. Author

**N91-16991** Illinois Univ., Urbana-Champaign.
**AN EXPERIMENTAL INVESTIGATION OF THE TWO-STREAM, SUPERSONIC, NEAR-WAKE FLOWFIELD BEHIND A FINITE-THICKNESS BASE Ph.D. Thesis**
Vincent Andrew Amatucci 1990 366 p
Avail: Univ. Microfilms Order No. DA9026120

The interaction region generated by separation of two supersonic streams past a finite-thickness base occurs in high-speed flight and characterizes the aft-end flowfield of powered missiles in supersonic flight. In order to examine fundamental mechanisms and interactions ongoing in this near-wake region, an experimental investigation was conducted to obtain mean and turbulence data in a wind tunnel. The test section produced a Mach 2.56 upper stream and a Mach 2.05 lower stream which both undergo geometric separation past a finite-thickness plate and experience strong expansion and mixing processes before eventual recompression, reattachment, and redevelopment of the wake flow. This near-wake flowfield is characterized by strong velocity and density gradients, viscous interactions, high turbulence levels, and energetic recirculation. The data was obtained using Schlieren photographs, stagnation and static pressure measurements, and laser Doppler velocimeter (LDV)

measurements. The primary tool was a two-color, two-component LDV system. The data was analyzed in component approach consistent with the Chapman-Korst model. The flow regions included Prandtl-Meyer expansions, shear layer mixing and recompression, recirculation, and wake redevelopment. The shear layer mixing regions and separated flow regions were characterized. While self-similarity of mean velocity data was achieved, the turbulence field did not reach that state before recompression began. Turbulence intensities, Reynolds stresses, and triple products increased in the latter portions of both shear layers and in the recompression/reattachment region, indicating the presence of large-scale structures. The turbulence field near reattachment was strongly anisotropic, and transverse diffusion of turbulence energy agreed with existing correlations. Recovery of the mean velocity field remained perturbed. Dissert. Abstr.

**N91-16992*#** Arizona State Univ., Tempe. Dept. of Mechanical and Aerospace Engineering.

**NEAR-WALL MODELLING OF COMPRESSIBLE TURBULENT FLOWS Semiannual Progress Report, 1 Jul. - 31 Dec. 1990**

Ronald M. C. So 31 Dec. 1990 50 p

(Grant NAG1-1080)

(NASA-CR-187731; NAS 1.26:187731) Avail: NTIS HC/MF A03 CSCL 01A

Work was carried out to formulate near-wall models for the equations governing the transport of the temperature-variance and its dissipation rate. With these equations properly modeled, a foundation is laid for their extension together with the heat-flux equations to compressible flows. This extension is carried out in a manner similar to that used to extend the incompressible near-wall Reynolds-stress models to compressible flows. The methodology used to accomplish the extension of the near-wall Reynolds-stress models is examined and the actual extension of the models for the Reynolds-stress equations and the near-wall dissipation-rate equation to compressible flows is given. Then the formulation of the near-wall models for the equations governing the transport of the temperature variance and its dissipation rate is discussed. Finally, a sample calculation of a flat plate compressible turbulent boundary-layer flow with adiabatic wall boundary condition and a free-stream Mach number of 2.5 using a two-equation near-wall closure is presented. The results show that the near-wall two-equation closure formulated for compressible flows is quite valid and the calculated properties are in good agreement with measurements. Furthermore, the near-wall behavior of the turbulence statistics and structure parameters is consistent with that found in incompressible flows. Author

**N91-16993*#** Naval Research Lab., Washington, DC.

**COMPRESSIBILITY EFFECTS ON DYNAMIC STALL OF OSCILLATING AIRFOILS Final Report**

M. S. Chandrasekhara and M. F. Platzer 23 Aug. 1990 42 p

Sponsored in part by NASA, Ames Research Center; Army; Navy; and AF

(Contract MIPR-ARO-137-86; ARO-23394-EG)

(NASA-CR-187870; NAS 1.26:187870; AD-A228046; ARO-23394.10-EG) Avail: NTIS HC/MF A03 CSCL 01/1

This study's aim was to obtain a basic understanding of the effect of compressibility on the phenomenon of dynamic stall under typical flight conditions encountered by a helicopter in forward flight, so that eventually a means for its control can be devised and thus, its flight envelope can be expanded. The first phase of the study was devoted to building a drive system to produce the necessary unsteady airfoil motion. A novel design was arrived at and built. It uses a four-bar chain mechanism of which the airfoil is one of the links. The drive can produce a sinusoidal variation of the angle of attack as: alpha = alpha sub 0 + alpha sub m(sin omega+), with the mean angle of attack alpha0, continuously variable from 0 to 15 deg, the amplitude of oscillation alpha sub m, from 2 to 10 degs and the frequency from 0 to 100 Hz, in an oncoming flow Mach number M, from 0 to 0.5. The drive was installed in the indraft wind tunnel at NASA Ames Research Center. Stroboscopic schlieren studies and interferograms as well as holographic interferometry studies were conducted for a wide range of flow conditions, amplitudes and frequencies. Results show that compressibility effects appear at M = 0.3, that a dynamic stall vortex forms for all Mach numbers, and that for M is greater than or = 0.3, the dynamic stall angle decreases as M increases. On the otherhand, increasing the degree of unsteadiness, delays deep stall monotonically at all Mach numbers. GRA

**N91-16994** Texas Univ., Arlington.

**EXPERIMENTAL STUDY OF A TWO-DIMENSIONAL PROPULSIVE WING IN A LOW-SPEED WIND TUNNEL Ph.D. Thesis**

Chang Soo Jeon 1990 219 p

Avail: Univ. Microfilms Order No. DA9033482

The experimental study of 2-dimensional propulsive wing in a low speed wind tunnel was performed to general an experimental data bank which can help future possible evolutions of STOL aircraft. A model employing a modified NACA 0025 airfoil sections with three different height-to-chord ratio propulsive nozzles exhausting over the upper surface of the airfoil at the 70 percent chord position was tested. Test data were obtained for angles of attacks of -5, 0, 5, 10, and 15 degrees, referenced to the coordinate system of the symmetric NACA 0025 airfoil, and at wind tunnel dynamic pressures of 0, 1, 51, and 10 lbf/sq ft. The propulsive flow was simulated by a compressed air source with nozzle pressure ratios ranging from 1 to 1.4 and measured jet momentum coefficients from 0 to 18. A significant entrainment of air proceeding the nozzle exhaust station was observed that contributed directly to lift enhancement. The lift coefficient and entrainment velocity increment were found to correlate directly with the propulsive velocity increment. Different nozzle area ratios showed little effect on entrainment velocity increment of the external flow and thus on life coefficient. Lift enhancement beyond the effect of boundary layer control due to jet blowing was approximately predicted by the effective velocity ratio. Correlations based on momentum pressure parameters employing a 'neutral point' concept were also found to provide an excellent correlation of the lift enhancement and entrainment velocity. Jet-flap theory was compared with experimental results. Lift curve slopes of test results were always higher then theoretical ones. Wake data showed negative profile drag coefficients with power-on. Thrust recovery of the jet was independent of angle of attack and jet deflection angle. Flow visualization was used in an attempt to improve understanding of the fundamental flow structure of the propulsive wing.

Dissert. Abstr.

**N91-16995** Colorado Univ., Boulder.

**A MULTIPLE FRAMES OF REFERENCE APPROACH TO AEROELASTIC COMPUTATIONS: APPLICATION TO AIRFOIL FLUTTER ANALYSIS Ph.D. Thesis**

Tzer-Yuaan Lin 1990 152 p

Avail: Univ. Microfilms Order No. DA9032852

In order to predict the dynamic response of a rigid or flexible structure in a fluid flow, the equations of motion of the structure and the fluid must be solved simultaneously. A straightforward approach to the solution of the coupled fluid/structure dynamic equations requires moving at each time step at least the portions of the fluid grid that are close to the moving structure. A more economical approach is derived for the transient solution of the aeroelastic coupled problem. The governing equations of motion of the fluid is derived with respect to multiple moving frames of reference. Each of these frames is attached to a carefully selected node of the discretized structure. For a rigid aeroelastic configuration, the result is the implicit generation of a structure-attached corotational fluid grid. In this case, so single grid point needs to be explicitly moved or updated during the transient analysis, even when the structure undergoes large rigid-body motion. If the effect of small elastic deformations is also to be included, the spatial metrics used for computing the unsteady flow soltuions need to be continuously modified according to the deforming shape of the structure. Consequently, a spatial metrics updating scheme is also developed in addition to the corotational approach. The proposed approach for fluid/structure interaction problems rests on two essential ingredients: a flow

solver, and a structure analyzer. Time accurate Euler/Navier-Stokes solvers are considered for unsteady flow computations. The ARC2D code is selected and modified to handle the fluid part while an in-house developed finite element code is chosen to analyze the structure. Both codes are modified to interact according to the proposed coupling strategy. The proposed approach for coupled simulation is first validated with the prediction of unsteady flow and the flutter analysis of a NACA0012 airfoil. Next, it is applied to investigate the aeroelastic response of an infinite flexible wing-like structure in transonic flow. Dissert. Abstr.

**N91-16996** Texas Univ., Austin.
**HIGH-ALTITUDE HYPERSONIC AERODYNAMICS OF BLUNT BODIES Ph.D. Thesis**
Walter Harmon Rutledge 1990 285 p
Avail: Univ. Microfilms Order No. DA9031704

A computational fluids dynamics scheme is presented to solve the unsteady thin layer Navier-Stokes (TLNS) equations over a blunt body at high altitude, high Mach number atmospheric reentry flow conditions. This continuum approach is directed to low density hypersonic flows by accounting for non-zero bulk viscosity effects in near frozen flow conditions. The TLNS equations are solved over an axisymmetric body at zero incidence relative to the free stream. The time dependent axisymmetric governing equations are transformed into a computational plane, then cast into weak conservative form and solved using a first-order fully implicit scheme in time with second-order flux vector splitting for spatial derivatives. The resulting implicit matrix from this finite-difference scheme is inverted using a line successive-over-relaxation (SOR) method. The numerical procedure also utilizes an increasing Courant-Friedrichs-Lewy (CFL) number with time resulting in a non-time accurate scheme which provides accelerated convergence to the desired steady-state solution. The computational space is defined over representative sphere and sphere/cone geometries using a body-fitted clustered algebraic grid within a fixed domain. The thermochemical effects at high altitudes are modeled using a frozen flow assumption. At lower altitudes, an equilibrium chemistry package is used to model real gas effects. The effects of high temperature transport properties are included. At the present time, nonequilibrium thermochemistry effects are not modeled. Catalytic wall, ionization, and radiation effects are also not excluded from the current analysis. However, the significant difference from previous studies is the inclusion of the capability to model non-zero bulk viscosity effects. The importance of bulk viscosity is reviewed and several blunt body flow field solutions are presented to illustrate the potential contribution of this phenomena at high altitude hypersonic conditions. The current technique is compared with experimental data and other approximate continuum solutions. A variety of test cases are also presented for a wide range of free stream Mach conditions. Discussion of the results includes representative trends at chemical equilibrium as well as at frozen flow conditions.
Dissert. Abstr.

**N91-16997** Purdue Univ., West Lafayette, IN.
**AERODYNAMICS OF A LINEAR OSCILLATING CASCADE Ph.D. Thesis**
Daniel Havens Buffum 1990 262 p
Avail: Univ. Microfilms Order No. DA9031301

The aerodynamics of a linear oscillating cascade are investigated using experimental and computational methods. Experiments are performed to quantify the torsion mode oscillating cascade aerodynamics of the NASA Lewis Transonic Oscillation Cascade for subsonic inlet flow field using two methods: (1) simultaneous oscillating of all the cascaded airfoils at various values of interblade phase angle; and (2) the unsteady aerodynamic influence of coefficient technique. Analysis of these data and correlation with classical linearized unsteady aerodynamic analysis predictions indicate that the wind tunnel walls enclosing the cascade have, in some cases, a detrimental effect on the cascade unsteady aerodynamics. An Euler code for oscillating cascade aerodynamics is modified to incorporate improved upstream and downstream boundary conditions and also the unsteady aerodynamic influence coefficient technique. The new boundary conditions are shown to improve the unsteady aerodynamic predictions of the code, and the computational unsteady aerodynamic influence coefficient technique is shown to be a viable alternative for calculation of oscillating cascade aerodynamics.
Dissert. Abstr.

**N91-16998#** Royal Aircraft Establishment, Farnborough (England).
**THE EFFECT OF A SPLITTER PLATE ON THE SYMMETRY OF SEPARATED FLOW AROUND A DELTA WING OF LOW ASPECT RATIO**
S. B. Zakharov Mar. 1990 13 p Transl. into ENGLISH from Vliyanie Razdelitel'noi Plastiny na Simmetrichnost' Otryvnogo Obtekaniya Treugol'nogo Kryla Malogo Udlineniya, Uchenye Zapiski Tsagi (USSR), v. 17, no. 3, 1986
(BR115576; RAE-LT-2177) Copyright Avail: NTIS HC/MF A03

Using the approximation of the theory of slender bodies, an investigation is made into the non-uniqueness of solutions for separated flow around a delta wing of low aspect ratio in the presence of a delta splitter plate on the upper surface of the wing and in the plane of symmetry. An improved method of formulation offers increased accuracy, when applied to the solution of similarity problems in vortex sheets. Some substantially asymmetrical solutions to the problem of separated flow around the wing under symmetrical conditions of flow are obtained, as well as some symmetrical ones. Considerable attention is paid to an explanation of the nature of the bifurcations in solutions and to a qualitative description of hysteresis in the aerodynamic characteristics as a result of a quasi-stationary change in angle of attack and yaw angle by the use of a simplified mathematical model of a vortex sheet vortex and cut. Author

**N91-16999*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
**MULTI-COLORED LAYERS FOR VISUALIZING AERODYNAMIC FLOW EFFECTS Patent Application**
Ronald N. Jensen, inventor (to NASA) 3 Dec. 1990 7 p
(NASA-CASE-LAR-13742-1; NAS 1.71:LAR-13742-1; US-PATENT-APPL-SN-621144) Avail: NTIS HC/MF A02 CSCL 01A

A method is provided for visualizing aerodynamic flow effects on a test surface. First, discrete quantities of a sublimating chemical such as naphthalene are distinctively colored via appropriate dyes or paints. Next, a uniform layer of the sublimating chemical having a particular color is applied to the test surface. This layer is covered with a second uniform layer of a different colored sublimating chemical, and so on until a composite of multi-colored layers is formed having a discrete thickness. Friction caused by an airflow results in the distinctly colored layers being removed in proportion to such aerodynamic flow characteristics as velocity and temperature, resulting in a multi-colored portrait which approximates the air flow on the underlying test surface. NASA

**N91-17000*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**NATURALLY OCCURRING AND FORCED AZIMUTHAL MODES IN A TURBULENT JET**
Ganesh Raman, Edward J. Rice, and Eli Reshotko (Case Western Reserve Univ., Cleveland, OH.) 1991 10 p Proposed for presentation at the 1991 Joint ASME-JSME Fluids Engineering Conference, Portland, OR, 24-26 Jun. 1991; cosponsored by ASME and Japanese Society of Mechanical Engineers
(Contract NAS3-25266)
(NASA-TM-103692; E-5911; NAS 1.15:103692) Avail: NTIS HC/MF A02 CSCL 01A

Naturally occurring instability modes in an axisymmetric jet were studied using the modal frequency technique. The evolution of the modal spectrum was obtained for a jet with a Reynolds number based on a diameter of 400,000 for both laminar and turbulent nozzle boundary layers. In the early evolution of the jet the axisymmetric mode was predominant, with the azimuthal modes growing rapidly but dominating only the end of the potential core.

The growth of the azimuthal was observed closer to the nozzle exit for the jet in the laminar boundary layer case than for the turbulent. Target modes for efficient excitation of the jet were determined and two cases of excitation were studied. First, a jet was excited simultaneously by two helical modes, m equals plus 1 and m equals minus 1 at a Strouhal number based on jet diameter of 0.15 and the axisymmetric mode, m equals 0 at a jet diameter of 0.6. Second, m equals plus one and m equals minus 1 at jet diameter equals 0.3 and m equals 0 at jet diameter equals 0.6 were excited simultaneously. The downstream evolution of the hydrodynamic modes and the spreading rate of the jet were documented for each case. Higher jet spreading rates, accompanied by distorted jet cross sections were observed for the cases where combinations of axisymmetric and helical forcings were applied. Author

**N91-17001*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
**AN EVALUATION OF THREE TWO-DIMENSIONAL COMPUTATIONAL FLUID DYNAMICS CODES INCLUDING LOW REYNOLDS NUMBERS AND TRANSONIC MACH NUMBERS**
Raymond M. Hicks and Susan E. Cliff Jan. 1991 50 p
(NASA-TM-102840; A-90202; NAS 1.15:102840) Avail: NTIS HC/MF A03 CSCL 01A

Full-potential, Euler, and Navier-Stokes computational fluid dynamics (CFD) codes were evaluated for use in analyzing the flow field about airfoils sections operating at Mach numbers from 0.20 to 0.60 and Reynolds numbers from 500,000 to 2,000,000. The potential code (LBAUER) includes weakly coupled integral boundary layer equations for laminar and turbulent flow with simple transition and separation models. The Navier-Stokes code (ARC2D) uses the thin-layer formulation of the Reynolds-averaged equations with an algebraic turbulence model. The Euler code (ISES) includes strongly coupled integral boundary layer equations and advanced transition and separation calculations with the capability to model laminar separation bubbles and limited zones of turbulent separation. The best experiment/CFD correlation was obtained with the Euler code because its boundary layer equations model the physics of the flow better than the other two codes. An unusual reversal of boundary layer separation with increasing angle of attack, following initial shock formation on the upper surface of the airfoil, was found in the experiment data. This phenomenon was not predicted by the CFD codes evaluated. Author

**N91-17002*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**OPTICAL MEASUREMENT OF PROPELLER BLADE DEFLECTIONS IN A SPIN FACILITY**
John K. Ramsey, Erwin H. Meyn, Oral Mehmed, and Anatole P. Kurkov Oct. 1990 11 p
(NASA-TM-103115; E-5439; NAS 1.15:103115) Avail: NTIS HC/MF A03 CSCL 01A

A nonintrusive optical system for measuring propeller blade deflections has been used in the NASA Lewis dynamic spin facility. Deflection of points at the leading and trailing edges of a blade section can be obtained with a narrow light beam from a low power helium-neon laser. A system used to measure these deflections at three spanwise locations is described. Modifications required to operate the lasers in a near-vacuum environment are also discussed. Author

**N91-17003** Technische Univ., Brunswick (Germany, F.R.). Inst. fuer Stroemungsmechanik.
**GAS KINETIC SIMULATION OF HYPERSONIC FLOWS PAST THREE-DIMENSIONAL BLUNT BODIES UNDER REENTRY CONDITIONS Ph.D. Thesis**
W. Wetzel Dec. 1989 88 p In GERMAN; ENGLISH summary
(ZLR-FB-89-02; ISBN-3-9802073-1-5; ETN-91-98642) Copyright Avail: Fachinformationszentrum Karlsruhe, 7514 Eggenstein-Leopoldshafen 2, Fed. Republic of Germany

The direct simulation Monte Carlo method, as developed by Bird, is used to investigate the hypersonic flow past a 3-D body in the transitional regime between continuum and free molecular flow. The results of 3-D Monte Carlo calculations based on cold hypersonic flow conditions are compared to experimental data in order to verify the code. The relaxation process in an homogeneous gas is simulated. These results are compared with the analytic solution of the Lighthill gas. In both cases, the agreement is good. The 3-D code, extended to the real gas model, is applied to hypersonic flow past blunt bodies under reentry conditions. The influence of the real gas effects on the flow field and on the heat flux is presented and discussed. A proposal concerning a new gas surface interaction model for technical surfaces under orbital conditions is made. ESA

**N91-17004#** Arizona Univ., Tucson. Dept. of Aerospace and Mechanical Engineering.
**COMPUTATIONAL STUDIES OF COMPRESSIBILITY EFFECTS ON DYNAMIC STALL Final Report, 1 Jun. 1988 - 31 Aug. 1990**
K.-Y. Fung 27 Sep. 1990 94 p Presented at the NASA/AFOSR/ARO Workshop, Moffett Field, CA, 17-19 Apr. 1990
(Grant AF-AFOSR-0163-88; AF Proj. 2307)
(AD-A229007; AFOSR-90-1131TR) Avail: NTIS HC/MF A05 CSCL 01/1

The dynamic stall characteristics of several airfoils in sinusoidal pitch oscillations as well as in constant rate pitch ramps over a wide range of unsteady flow conditions have been investigated. It is found that: (1) the flow before the onset of stall can be considered quasi-steady and predicted using inviscid theory; (2) the effect of unsteadiness on the onset of dynamic stall depends on the airfoil geometry and whether the flow has become locally supersonic; and (3) the effect of the freestream Mach number on the onset is rather insensitive to the airfoil geometry. Our analysis on both experimental and numerical results predicts the presence of a separation bubble at the leading edge. It also suggests that the bursting of the bubble, or failure to reattach after the initial separation, is the onset mechanism for most of the dynamic stall cases studied. The effects of transition on bubble bursting (the onset of massive separation of dynamic stall) are studied numerically by choosing the location at which the turbulence model is switched from molecular to turbulent eddy viscosity in the numerical code. It was found that at angles of attack close to the static stall angle, minor movements in the transition point could cause a separation bubble to burst, and that bubble bursting is more susceptible to transition point location in a locally supersonic flow than a subsonic flow. GRA

# 03 AIR TRANSPORTATION AND SAFETY

Includes passenger and cargo air transport operations; and aircraft accidents.

For related information see also *16 Space Transportation* and *85 Urban Technology and Transportation.*

**N91-17005#** Federal Aviation Administration, Atlantic City, NJ.
**FLIGHT EVALUATION OF SEVERAL GROUND DEICING/ANTI-ICING FLUIDS ON GENERAL AVIATION AIRCRAFT Final Report**
David L. Kohlman and Mahyar Rahbarrad (Kohlman Aviation Corp., Colorado Springs, CO.) Dec. 1990 90 p
(Contract DTFA03-90-P-00804)
(DOT/FAA/CT-TN90/31) Avail: NTIS HC/MF A05

The aerodynamic effects of aircraft ground deicing/anti-icing fluids is a topic that has received increasing attention in recent years as the use of these fluids becomes more widespread and sophisticated. An important consideration with respect to the use of these fluids is the effect of residual fluid remaining on the aircraft during the takeoff roll and initial climb. A flight test program to determine these effects on the takeoff and climb performance for two general aviation aircraft was conducted. The flight tests were performed in Topeka, Kansas, and Duluth, Minnesota. Results indicate that the presence of the deicing/anti-icing fluids on the

aerodynamic surfaces of the test aircraft can reduce aerodynamic lift and increase liftoff airspeed. However, the flight test pilots reported no obvious changes in the performance of handling characteristics of the aircraft. Author

**N91-17006#** National Inst. of Standards and Technology, Gaithersburg, MD.
**EVALUATION OF EXIT SIGNS IN CLEAR AND SMOKE CONDITIONS**
Belinda L. Collins, Mubarak S. Dahir, and Daniel Madrzykowski Aug. 1990 79 p
(PB90-269523; NISTIR-4399) Avail: NTIS HC/MF A05 CSCL 01C

A short review of the research literature on the visibility of exit signs, directional markings, and emergency lighting is presented. A study is also presented which assessed the visibility of several types of exit signs including conventional and electroluminescent (EL) signs in both clear and smokey conditions. Signs were measured photometrically in clear conditions with two different photometers in a laboratory to determine their luminance under dark conditions and with an ambient room illuminance of 54 lx (5 fc). Analysis of these data indicated very wide variations in luminance as a function of sign type. The visibility of the signs on both clear conditions and smoke were also assessed psychophysically. Analysis of the data indicated that overall sign luminance was one of the primary determinants of visibility in smoke conditions, while uniformity was also an important contributor. The data indicated that some EL signs can be effective in clear conditions and in smoke. Author

**N91-17007#** Federal Aviation Administration, Washington, DC. Office of Safety Analysis.
**STUDY OF THE RELATIONSHIPS BETWEEN NEAR MIDAIR COLLISIONS (NMAC'S), MIDAIR COLLISIONS (MAC'S) AND SOME POTENTIAL CAUSAL FACTORS**
Joel M. Yesley Mar. 1990 30 p
(PB90-268491) Avail: NTIS HC/MF A03 CSCL 01C

The relationships between near midair collision (NMAC) and midair collision (MAC) incidence and some potential explanatory factors was examined by using regression techniques. In addition, the hypothetical existence of a relationship between NMAC and MAC incidence was examined in detail. All NMAC's and MAC's occurring within major airport hubs over the 1984 to 1986 period were examined in the first part. No statistically significant relationships were found to exist between the occurrence of NMAC's and MAC's over the entire 1981 to 1986 period, although the correlation was considerably stronger over the 1983 to 1986 period. Author

**N91-17008#** Federal Aviation Administration, Atlantic City, NJ.
**INVESTIGATION OF ACCIDENTAL DC-7 FIRE DAMAGE OCCURRING JUNE 28, 1989**
Thomas Rust et al Dec. 1990 41 p
(DOT/FAA/CT-TN89/55) Avail: NTIS HC/MF A03

Three groups of investigators were formed to determine the circumstances that caused an accidental, fuselage-destroying fire that occurred on June 28, 1989, in the research and development area of the FAA Technical Center. From interviews with witnesses and analysis of the structural fire damage to the fuselage, a probable sequence of events was developed and an analysis of the contributing causes of the damage was determined. A number of recommendations for future test scenarios were established in order to prevent the extensive fire damage that resulted during this test. Author

**N91-17009*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
**AVIATION SAFETY AND AUTOMATION TECHNOLOGY FOR SUBSONIC TRANSPORTS**
James A. Albers Jan. 1991 54 p Presented at the 1991 AIAA International Aerospace Conference and Engineering Show, 13 Feb. 1991, Los Angeles, CA
(NASA-TM-103831; A-91039; NAS 1.15:103831) Avail: NTIS HC/MF A04 CSCL 01C

Discussed here are aviation safety human factors and air traffic control (ATC) automation research conducted at the NASA Ames Research Center. Research results are given in the areas of flight deck and ATC automations, displays and warning systems, crew coordination, and crew fatigue and jet lag. Accident investigation and an incident reporting system that is used to guide the human factors research is discussed. A design philosophy for human-centered automation is given, along with an evaluation of automation on advanced technology transports. Intelligent error tolerant systems such as electronic checklists are discussed along with design guidelines for reducing procedure errors. The data on evaluation of Crew Resource Management (CRM) training indicates highly significant positive changes in appropriate flight deck behavior and more effective use of available resources for crew members receiving the training. Author

**N91-17010#** Systems Control Technology, Inc., Arlington, VA.
**ANALYSIS OF HELICOPTER MISHAPS AT HELIPORTS, AIRPORTS, AND UNIMPROVED SITES Final Report**
Len D. Dzamba, Robert J. Hawley, and Richard J. Adams Jan. 1991 78 p Prepared in cooperation with Advanced Aviation Concepts, Jupiter, FL
(Contract DTFA01-87-C-00014)
(SCT-90RR-46; DOT/FAA/RD-90/8) Avail: NTIS HC/MF A05

A task was undertaken to determine possible inadequacies in FAA design standards and guidelines set forth in the Heliport Design Advisory Circular (AC 150/5390-2). This report is based upon the results of an analysis of helicopter mishaps which occurred within a 1 mile radius of various landing sites, including heliports, airports, and unimproved sites. NTSB and U.S. Army reports describing mishaps that occurred at or near a facility were used. The focus of the analysis was to determine the manner in which facility design may contribute to the mishaps. Particular attention was given to issues concerning the size, obstruction clearance, and adequacy of facility protected airspace and operational areas. Mishap type and location, as well as the applicable design issues, were analyzed from the reports and are discussed. It is concluded that overall, the Heliport Design Advisory Circular provides very good guidelines for heliport design and is a valid instrument. Several areas for possible improvement within the document have been identified. Recommendations include areas addressing obstruction marking, facility maintenance, wind indicator location, and guidelines for operations at airports. Author

# 04 AIRCRAFT COMMUNICATIONS AND NAVIGATION

Includes digital and voice communication with aircraft; air navigation systems (satellite and ground based); and air traffic control.

For related information see also *17 Space Communications, Spacecraft Communications, Command and Tracking* and *Communications and Radar.*

**N91-17011#** Federal Aviation Administration, Atlantic City, NJ.
**MICROWAVE LANDING SYSTEM (MLS) BACK AZIMUTH OPERATIONAL ISSUES FLIGHT TESTS Technical Note, Dec. 1989 - May 1990**
Edward J. Pugacz Sep. 1990 23 p
(Contract FAA-T06039)
(AD-A228659; DOT/FAA/CT-TN90/3) Avail: NTIS HC/MF A03 CSCL 17/7

This test plan describes a series of flight tests using Microwave Landing System (MLS) back azimuth guidance for missed approach and departure procedures. Issues to be addressed during these flight tests are: (1) The proper point in a missed approach to switch from approach azimuth to back azimuth guidance; (2) the largest MLS back azimuth offset angle usable for departures and missed approaches; and (3) the correct back azimuth full scale

sensitivity. Approximately 10 industry pilots will participate as test subjects. The flights will be tracked by a radar tracker throughout each procedure. Individual and composite plots of each approach will be produced, and answers to in-flight and post-flight questionnaires will be complied. The processed data will be made available to the international aviation community to aid in the formulation of back azimuth usage guidelines. GRA

**N91-17012#** Royal Aerospace Establishment, Farnborough (England).

**ADVANCES IN NAVIGATION SUPPORT SYSTEMS BASED ON OPERATIONAL PILOT'S HEURISTICS**

F. Deblon, A. Guengant, C. Valot, R. Amalberti (Centre d'Enseignement et de Recherches de Medecine Aeronautique, Paris, France ), and E. J. Lovesey, ed. Aug. 1990 26 p Transl. into ENGLISH from conference paper Presented at the Advances in Techniques and Technologies for Air Vehicle Navigation and Guidance Symposium, Lisbon, Portugal, 9-12 May 1989 Original language document was announced as N90-16737

(RAE-TRANS-2184; BR115578) Avail: NTIS HC/MF A03

The combination of the future high threat battlefield environment and the trend toward single seat combat aircraft provides the need to develop on-board decision support systems. The Pilot's Assistant offers a means of fulfilling such a requirement. While this concept covers different classes of aids, the development of a navigation support system is focused on. Special attention was paid to the quality of the man-machine interface of such a real time aid. It is suggested that because the quality of this interface is critical, the best solution consists of computerizing the man's navigational expertise, (rather than with optimal multiexpert software). Thus the eliciting of pilot expertise, while conducting low level nap-of-the-earth penetration missions has been important. An artificial intelligence computer model of navigation is derived from this cognitive model with respect to the use of a concurrent object oriented language. An extended description of this program is given, including ways of implementing the Pilot's Assistant in future French aircraft. Author

**N91-17013** Deutsche Geodaetische Kommission, Munich (Germany, F.R.).

**DETERMINATION OF THE CINEMATIC POSITION FOR THE AEROTRIANGULATION, USING THE NAVSTAR GLOBAL POSITIONING SYSTEM Ph.D. Thesis - Stuttgart Univ. [KINEMATISCHE POSITIONSBESTIMMUNG FUER DIE AEROTRIANGULATION MIT DEM NAVSTAR GLOBAL POSITIONING SYSTEM]**

Peter Friess 1990 146 p In GERMAN

(SER-C-359; ISBN-3-7696-9407-4; ISSN-0065-5325; ETN-91-98641) Copyright Avail: Deutsche Geodaetische Kommission, D-8000 Munich 22, Marstallplatz 8, Postfach 220 002, Fed. Republic of Germany

The development of the satellite aided Navigation System with Time And Ranging (NAVSTAR) Global Position System (GPS) offers new possibilities for the direct determination of external orientation parameters. The principles for the determination of the position are given, using artificial satellites. The methods and models for satellite tracking calculations and distance determination are described. The accuracy of factors influencing the position determination is shown. The development phases, system components, available data and reference system for the NAVSTAR GPS are presented. An empirical analysis of NAVSTAR GPS for cinematic position determination is focused. The mathematical model is amplified by additional observation equations for the GPS antennas coordinates. The effect of observed orientation parameters on the accuracy of block triangulation is simulated. ESA



# 05 AIRCRAFT DESIGN, TESTING AND PERFORMANCE

Includes aircraft simulation technology.

For related information see also *18 Spacecraft Design, Testing and Performance* and *39 Structural Mechanics*.For land transportation vehicles see *85 Urban Technology and Transportation*.

**N91-17014*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

**STATIC FOOTPRINT LOCAL FORCES, AREAS, AND ASPECT RATIOS FOR THREE TYPE 7 AIRCRAFT TIRES**

William E. Howell, Sharon E. Perez, and William A. Vogler (Lockheed Engineering and Sciences Co., Hampton, VA.) Washington Feb. 1991 95 p

(NASA-TP-2983; L-16521; NAS 1.60:2983) Avail: NTIS HC/MF A05 CSCL 01C

The National Tire Modeling Program (NTMP) is a joint NASA/industry effort to improve the understanding of tire mechanics and develop accurate analytical design tools. This effort includes fundamental analytical and experimental research on the structural mechanics of tires. Footprint local forces, areas, and aspect ratios were measured. Local footprint forces in the vertical, lateral, and drag directions were measured with a special footprint force transducer. Measurements of the local forces in the footprint were obtained by positioning the transducer at specified locations within the footprint and externally loading the tires. Three tires were tested: (1) one representative of those used on the main landing gear of B-737 and DC-9 commercial transport airplanes, (2) a nose landing gear tire for the Space Shuttle Orbiter, and (3) a main landing gear tire for the Space Shuttle Orbiter. Data obtained for various inflation pressures and vertical loads are presented for two aircraft tires. The results are presented in graphical and tabulated forms. Author

**N91-17015** Virginia Polytechnic Inst. and State Univ., Blacksburg.

**OPTIMAL RIGID-BODY ROTATIONAL MANEUVERS Ph.D. Thesis**

Rajiv Singh Chowdhry 1989 176 p

Avail: Univ. Microfilms Order No. DA9017038

Optimal rigid-body angular maneuvers are investigated, using restricted control moments - a problem inspired in the context of rotational maneuvers for super-maneuverable aircraft. Most of the analysis is based on the formulation with no direct control over the roll component of angular velocity. Optimal rigid-body angular rate control is examined via an approximate dynamic model. The proposed model admits analytical solutions of the optimality conditions. The analysis reveals that over a large range of boundary conditions, there are, in general, several distinct extremal solutions. Second-order necessary conditions are investigated to establish local optimality of candidate minimizers. Global optimality of the extremal solutions is discussed. Next, the optimal angular rate problem is studied using the exact dynamic model. Numerical solutions of optimality conditions are obtained which corroborate and extend the findings of the approximate problem. The qualitative features of multiple extremal solutions did not satisfy the Jacobi necessary condition. The choice of minimizing solution could be narrowed down to two sub-families of extremal solutions. The studies look at minimum control effort families of extremal solutions. As a next step, the minimum time control of angular rates is examined with prescribed hard bounds on available control. Existence of singular subarcs in time-optimal trajectories is explored. Qualitative features exhibited by the exact problem are preserved. In addition, the control space is deformed to allow roll control and its effect on extremal solutions is investigated. The kinematics are introduced into the optimal control problem. Minimum time attitude control of a rigid-body is investigated with prescribed hard bounds on available control. The attitude of the rigid-body is defined using Euler parameters. Existence of singular subarcs in time-optimal trajectories is explored. Dissert. Abstr.

**N91-17016#** General Accounting Office, Washington, DC. National Security and International Affairs Div.
**NAVAL AVIATION: THE V-22 OSPREY, PROGRESS AND PROBLEMS**
12 Oct. 1990 11 p
(AD-A228905; GAO/NSIAD-91-45) Avail: NTIS HC/MF A03 CSCL 01/3

The V-22 is a tiltrotor aircraft designed to take off and land vertically like a helicopter and to fly like an airplane by tilting its wing-mounted rotors to function as propellers. The V-22 is being developed to perform various combat missions, including medium lift assault for the Marine Corps, combat search and rescue for the Navy, and long range special operations for the Air Force. The V-22 is intended to replace the CH-46 Sea Knight helicopter for the Marine Corps and to supplement existing aircraft for the Air Force. The Navy is developing the aircraft under a fixed price incentive contract with Bell Helicopter Textron, Inc., and Boeing Helicopter Company. The full scale development contract was awarded in May 1986 and requires the two contractors to produce six aircraft for flight testing and three for ground testing. It included an option to buy 12 aircraft under pilot production. The engine is being developed under a firm fixed price contract by the Allison Gas Turbine Division of General Motors. GRA

**N91-17017** California Univ., Los Angeles.
**A FINITE DIFFERENCE APPROXIMATION METHOD FOR FLEXIBLE FLIGHT STRUCTURES Ph.D. Thesis**
Joseph Samuel Cisneros 1990 147 p
Avail: Univ. Microfilms Order No. DA9034020

A recent area of interest is the development of numerical techniques to simulate control laws for flexible flight structures. The goal of any discrete scheme is to faithfully reproduce the structure and dynamics of the original system. This goal can become quite elusive, since the establishment of an analytic truth model is somewhat subjective, the structures typically being quite complex. The most popular method to date is the finite element method. A relatively overlooked method is to discretize the continuous partial differential equation model by means of finite differences. A modified approach to this method will be discussed here, in which the spatial coordinate is discretized by means of a finite difference and the temporal coordinate is then discretized by calculating the matrix exponential. Discrete representations of the wave equation and the Euler-Bernoulli equation are provided, which maintain the properties of the continuous system, in particular, those properties discussed by Prof. Balakrishnan in his state space formulation of these equations. In this formulation, the partial differential equations with boundary inputs are cast in state space form over a suitable Hilbert Space, similar to the finite dimensional LQR theory. In order to simulate this system and to arrive at computational verification of the continuous time-infinite dimensional results, an approach to the discretization of this system of equations called the finite-expo difference method (FED) is proposed. The consistency, stability, and hence convergence of FED is shown. Furthermore, by choosing higher order finite difference approximations of the spatial coordinate, it is shown that excellent modal approximations can be obtained. Dissert. Abstr.

**N91-17018#** Royal Aerospace Establishment, Bedford (England).
**THE RAE GENERIC VSTOL AIRCRAFT MODEL: GVAM87 DOCUMENTATION GUIDE**
E. A. M. Muir and M. G. Kellett Jan. 1990 89 p
(RAE-TM-FM-38; BR115855) Copyright Avail: NTIS HC/MF A05

An unclassified, extended version of the RAE Bedford's mathematical Generic VSTOL Aircraft Model (GVAM) was developed to provide RAE, British industry, and universities with a comprehensive, nonlinear, vectored thrust aircraft model for use in Advanced Short Take Off and Vertical Landing (ASTOVL) control law design studies and real time piloted simulation. New modes of operation for the aerodynamic control surfaces, nozzles, and reaction control systems were introduced as well as plenum chamber burners on the front nozzles and an optional chin fin. The configuration can be varied to include some or all of these additional motivators, allowing the user to tailor the model to his own requirements. Author

**N91-17019#** Aerospace Medical Research Labs., Wright-Patterson AFB, OH.
**BASEOPS DEFAULT PROFILES FOR TRANSIENT MILITARY AIRCRAFT Interin Report, Sep. 1989 - Feb. 1990**
Wayne R. Lundberg Feb. 1990 79 p
(AD-A229184; AAMRL-TR-90-028) Avail: NTIS HC/MF A05 CSCL 20/1

Default Power Setting/Airspeed/Altitude vs. Distance Profiles for transient Military Aircraft takeoff and landings is described. The data cataloged are also accessible directly from the USAF BASEOPS program via the Load command. BASEOPS is a computerized operations input program for Airbase Noise analyses done under the Air Force Air Installation Compatible Use Zone (AICUZ) program. These profiles were adapted from the database previously developed for use at the Air Force Engineering Services Center (AFESC). Modifications were made to accommodate improved technical information on the flight performance and nominal thrust management for several military aircraft types. Due to the variability in operational parameters at different airbases for the same type aircraft, these data serve primarily as a guideline for input of transient aircraft profiles, which are not usually known to the airbase noise planner. GRA

**N91-17562*#** Boeing Military Airplane Development, Seattle, WA.
**ADVANCED EMBEDDED PROCESSING: PRESENT AND FUTURE**
Gerald C. Cohen *In* NASA, Langley Research Center, NASA Formal Methods Workshop, 1990 Nov. 1990 42 p (For primary document see N91-17559 09-61)
Avail: NTIS HC/MF A22 CSCL 01C

# 06 AIRCRAFT INSTRUMENTATION

Includes cockpit and cabin display devices; and flight instruments.

For related information see also *19 Spacecraft Instrumentation* and *35 Instrumentation and Photography.*

**N91-17020*#** National Aeronautics and Space Administration, Washington, DC.
**SPACE TRANSPORTATION AVIONICS TECHNOLOGY SYMPOSIUM. VOLUME 2: CONFERENCE PROCEEDINGS**
Aug. 1990 742 p Symposium held in Williamsburg, VA, 7-9 Nov. 1989
(NASA-CP-3081-VOL-2; NAS 1.55:3081-VOL-2) Avail: NTIS HC/MF A99 CSCL 22B

The focus of the symposium was to examine existing and planned avionics technology processes and products and to recommend necessary changes for strengthening priorities and program emphases. Innovative changes in avionics technology development and design processes are needed to support the increasingly complex, multi-vehicle, integrated, autonomous space-based systems. Key technology advances make such a major initiative viable at this time: digital processing capabilities, integrated on-board test/checkout methods, easily reconfigurable laboratories, and software design and production techniques. For individual titles, see N91-17021 through N91-17058.

**N91-17021*#** National Aeronautics and Space Administration, Washington, DC.
**NATIONAL SPACE TRANSPORTATION SYSTEM (NSTS) TECHNOLOGY NEEDS** **c16**
David L. Winterhalter and Kimberly K. Ulrich *In its* Space Transportation Avionics Technology Symposium. Volume 2: Conference Proceedings Aug. 1990 p 5-18 (For primary

document see N91-17020 09-06)
Avail: NTIS HC/MF A99 CSCL 22B

The National Space Transportation System (NSTS) is one of the Nation's most valuable resources, providing manned transportation to and from space in support of payloads and scientific research. The NSTS program is currently faced with the problem of hardware obsolescence, which could result in unacceptable schedule and cost impacts to the flight program. Obsolescence problems occur because certain components are no longer being manufactured or repair turnaround time is excessive. In order to achieve a long-term, reliable transportation system that can support manned access to space through 2010 and beyond, NASA must develop a strategic plan for a phased implementation of enhancements which will satisfy this long-term goal. The NSTS program has initiated the Assured Shuttle Availability (ASA) project with the following objectives: eliminate hardware obsolescence in critical areas, increase reliability and safety of the vehicle, decrease operational costs and turnaround time, and improve operational capability. The strategy for ASA will be to first meet the mandatory needs - keep the Shuttle flying. Non-mandatory changes that will improve operational capability and enhance performance will then be considered if funding is adequate. Upgrade packages should be developed to install within designated inspection periods, grouped in a systematic approach to reduce cost and schedule impacts, and allow the capability to provide a Block 2 Shuttle (Phase 3). Author

**N91-17022*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
**NEXT MANNED TRANSPORTATION SYSTEM** **c16**
Harry Erwin *In* NASA, Washington, Space Transportation Avionics Technology Symposium. Volume 2: Conference Proceedings Aug. 1990 p 19-83 (For primary document see N91-17020 09-06)
Avail: NTIS HC/MF A99 CSCL 22B

Avionics is the connecting link that integrates the hardware and software which satisfy systems requirements. Issues of the next manned transportation system are outlined: STS evolution; personnel launch system (PLS) sizing issues and constraints; PLS thermal protection system; PLS launch vehicle concepts; reliability and safety; advanced launch systems (ALS); near-term issues; avionics requirements; guideline to reduce operational costs; and critical human factors design considerations. B.G.

**N91-17023*#** National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
**CARGO LAUNCH VEHICLES TO LOW EARTH ORBIT** **c16**
Robert E. Austin *In* NASA, Washington, Space Transportation Avionics Technology Symposium. Volume 2: Conference Proceedings Aug. 1990 p 85-129 (For primary document see N91-17020 09-06)
Avail: NTIS HC/MF A99 CSCL 22B

There are two primary space transportation capabilities required to support both base programs and expanded mission requirements: earth-to-orbit (ETO) transportation systems and space transfer vehicle systems. Existing and new ETO vehicles required to support mission requirements, and planned robotic missions, along with currently planned ETO vehicles are provided. Lunar outposts, Mars' outposts, base and expanded model, ETO vehicles, advanced avionics technologies, expert systems, network architecture and operations systems, and technology transfer are discussed. B.G.

**N91-17024*#** National Aeronautics and Space Administration, Washington, DC.
**SPACE STATION FREEDOM AVIONICS TECHNOLOGY**
A. Edwards *In its* Space Transportation Avionics Technology Symposium. Volume 2: Conference Proceedings Aug. 1990 p 129-162 (For primary document see N91-17020 09-06)
Avail: NTIS HC/MF A99 CSCL 22B

The Space Station Freedom Program (SSFP) encompasses the design, development, test, evaluation, verification, launch, assembly, and operation and utilization of a set of spacecraft in low earth orbit (LEO) and their supporting facilities. The spacecraft set includes: the Space Station Manned Base (SSMB), a European Space Agency (ESA) provided Man-Tended Free Flyer (MTFF) at an inclination of 28.5 degrees and nominal attitude of 410 km, a USA provided Polar Orbiting Platform (POP), and an ESA provided POP in sun-synchronous, near polar orbits at a nominal altitude of 822 km. The SSMB will be assembled using the National Space Transportation System (NSTS). The POPs and the MTFF will be launched by Expendable Launch Vehicles (ELVs): a Titan 4 for the US POP and an Ariane for the ESA POP and MTFF. The US POP will for the most part use derivatives of systems flown on unmanned LEO spacecraft. The SSMB portion of the overall program is presented. Author

**N91-17025*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
**ASSURED CREW RETURN CAPABILITY CREW EMERGENCY RETURN VEHICLE (CERV) AVIONICS**
Harvey Dean Myers *In* NASA, Washington, Space Transportation Avionics Technology Symposium. Volume 2: Conference Proceedings Aug. 1990 p 163-177 (For primary document see N91-17020 09-06)
Avail: NTIS HC/MF A99 CSCL 22B

The Crew Emergency Return Vehicle (CERV) is being defined to provide Assured Crew Return Capability (ACRC) for Space Station Freedom. The CERV, in providing the standby lifeboat capability, would remain in a dormat mode over long periods of time as would a lifeboat on a ship at sea. The vehicle must be simple, reliable, and constantly available to assure the crew's safety. The CERV must also provide this capability in a cost effective and affordable manner. The CERV Project philosophy of a simple vehicle is to maximize its useability by a physically deconditioned crew. The vehicle reliability goes unquestioned since, when needed, it is the vehicle of last resort. Therefore, its systems and subsystems must be simple, proven, state-of-the-art technology with sufficient redundancy to make it available for use as required for the life of the program. The CERV Project Phase 1'/2 Request for Proposal (RFP) is currently scheduled for release on October 2, 1989. The Phase 1'/2 effort will affirm the existing project requirements or amend and modify them based on a thorough evaluation of the contractor(s) recommendations. The system definition phase, Phase 2, will serve to define CERV systems and subsystems. The current CERV Project schedule has Phase 2 scheduled to begin October 1990. Since a firm CERV avionics design is not in place at this time, the treatment of the CERV avionics complement for the reference configuration is not intended to express a preference with regard to a system or subsystem. Author

**N91-17026*#** National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
**SPACE TRANSFER VEHICLE AVIONICS ADVANCED DEVELOPMENT NEEDS**
C. F. Huffaker *In* NASA, Washington, Space Transportation Avionics Technology Symposium. Volume 2: Conference Proceedings Aug. 1990 p 179-227 (For primary document see N91-17020 09-06)
Avail: NTIS HC/MF A99 CSCL 22B

The assessment of preliminary transportation program options for the exploration initiative is underway. The exploration initiative for the Moon and Mars is outlined by mission phases. A typical lunar/Mars outpost technology/advanced development schedule is provided. An aggressive and focused technology development program is needed as early as possible to successfully support these new initiatives. The avionics advanced development needs, plans, laboratory facilities, and benefits from an early start are described. Author

**N91-17027*#** National Aeronautics and Space Administration, Washington, DC.
**EXPLORATION INITIATIVES: POST-APOLLO MANNED SPACEFLIGHT THRUSTS** **c12**
*In its* Space Transportation Avionics Technology Symposium.

Volume 2: Conference Proceedings Aug. 1990 p 229-246 (For primary document see N91-17020 09-06)
Avail: NTIS HC/MF A99 CSCL 22A

Post-Apollo manned spaceflight thrusts; pre-July 20, 1989 studies; Space Station, Moon, and Mars pathway; possible mission scenarios; lunar transportation vehicles; lunar evolution summary; Mars spacecraft; Shuttle derived launch vehicles; and critical areas of technology/advanced development for lunar and Mars missions are outlined. The presentation is represented by viewgraphs only. B.G.

**N91-17028*#** National Aeronautics and Space Administration, Washington, DC.
**RELIABILITY AND QUALITY EEE PARTS ISSUES** **c38**
Dan Barney and Irwin Feigenbaum (Vitro Corp., Washington, DC.) *In its* Space Transportation Avionics Technology Symposium. Volume 2: Conference Proceedings Aug. 1990 p 247-273 (For primary document see N91-17020 09-06)
Avail: NTIS HC/MF A99 CSCL 09D

NASA policy and procedures are established which govern the selection, testing, and application of electrical, electronic, and electromechanical (EEE) parts. Recent advances in the state-of-the-art of electronic parts and associated technologies can significantly impact the electronic designs and reliability of NASA space transportation avionics. Significant issues that result from these advances are examined, including: recent advances in microelectronics technology (as applied to or considered for use in NASA projects); electron packaging technology advances (concurrent with, and as a result of, the development of the advanced microelectronic devices); availability of parts used in space avionics; and standardization and integration of parts activities between projects, centers, and contractors. B.G.

**N91-17029*#** National Aeronautics and Space Administration, Washington, DC.
**OPERATIONAL EFFICIENCY: AUTOMATIC ASCENT FLIGHT DESIGN** **c16**
*In its* Space Transportation Avionics Technology Symposium. Volume 2: Conference Proceedings Aug. 1990 p 277-304 (For primary document see N91-17020 09-06)
Avail: NTIS HC/MF A99 CSCL 22B

Major objectives, milestones, key contacts, major accomplishments, technology issues, and candidate programs of the automatic ascent flight design are outlined. Topics discussed include: advanced avionics concepts; advanced training concepts; telerobotics/telepresence; integrated command and control; advanced software integration; atmospheric adaptive guidance; and health status and monitoring concept. This presentation is represented by viewgraphs only. B.G.

**N91-17030*#** National Aeronautics and Space Administration, Washington, DC.
**FLIGHT ELEMENTS SUBPANEL INTRODUCTION AND OVERVIEW** **c16**
Paul E. Sollock *In its* Space Transportation Avionics Technology Symposium. Volume 2: Conference Proceedings Aug. 1990 p 305-338 (For primary document see N91-17020 09-06)
Avail: NTIS HC/MF A99 CSCL 22B

Major objectives, milestones, key contacts, technology issues, accomplishments, and candidate programs are outlined. Topics addressed include: advanced avionics systems architectures; advanced information processing; avionics concepts; integrated Global Positioning System/guidance, navigation, and command concepts; advanced communication and telemetry; display and control concepts; advanced sensors and instrumentation; fault detection and fault management; advanced electric power, distribution, and control; EMA/power systems; and in-flight crew training. This presentation is represented by viewgraphs only. B.G.

**N91-17031*#** National Aeronautics and Space Administration, Washington, DC.
**PAYLOAD ACCOMMODATIONS: AVIONICS PAYLOAD SUPPORT ARCHITECTURE** **c16**
*In its* Space Transportation Avionics Technology Symposium. Volume 2: Conference Proceedings Aug. 1990 p 339-362 (For primary document see N91-17020 09-06)
Avail: NTIS HC/MF A99 CSCL 22B

Technology issues/trade studies; candidate programs; key contacts/facilities: milestones; accomplishments; and major objectives of the payload accommodation are outlined. Topics covered include: avionics payload support architecture; satellite serving; P/L deploy systems and advanced manipulators; advanced telemetry systems; and on-board abort planning. This presentation is represented by viewgraphs only. B.G.

**N91-17032*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
**SYSTEMS ENGINEERING AND INTEGRATION (SE AND I)** **c16**
Ed Chevers and Sam Haley *In* NASA, Washington, Space Transportation Avionics Technology Symposium. Volume 2: Conference Proceedings Aug. 1990 p 363-409 Prepared in cooperation with NASA, Marshall Space Flight Center, Huntsville, AL (For primary document see N91-17020 09-06)
Avail: NTIS HC/MF A99 CSCL 22B

The issue of technology advancement and future space transportation vehicles is addressed. The challenge is to develop systems which can be evolved and improved in small incremental steps where each increment reduces present cost, improves, reliability, or does neither but sets the stage for a second incremental upgrade that does. Future requirements are interface standards for commercial off the shelf products to aid in the development of integrated facilities; enhanced automated code generation system slightly coupled to specification and design documentation; modeling tools that support data flow analysis; and shared project data bases consisting of technical characteristics cast information, measurement parameters, and reusable software programs. Topics addressed include: advanced avionics development strategy; risk analysis and management; tool quality management; low cost avionics; cost estimation and benefits; computer aided software engineering; computer systems and software safety; system testability; and advanced avionics laboratories - and rapid prototyping. This presentation is represented by viewgraphs only. B.G.

**N91-17033*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
**OPERATIONAL EFFICIENCY: AUTOMATIC ASCENT FLIGHT DESIGN** **c16**
*In* NASA, Washington, Space Transportation Avionics Technology Symposium. Volume 2: Conference Proceedings Aug. 1990 p 415-422 (For primary document see N91-17020 09-06)
Avail: NTIS HC/MF A99 CSCL 22B

The expected increase in launch vehicle operations to support Space Station Freedom and a Lunar/Mars exploration initiative will require a more efficient approach to ascent flight design and operations. A concept is presented of continuous improvement in ascent flight design through an evolutionary process beginning with today's vehicles and continuing into the next century with the Advanced Launch System (ALS) and Advanced Manned Launch System (AMLS). A pictorial view is given of the improvement path described. The detailed objectives necessary to obtain efficiency improvements are described. The technology milestones along this evolutionary path are outlined and the accomplishments to date are summarized. The technology issues are discussed which must be addressed. Author

**N91-17034*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
**ADVANCED TRAINING SYSTEMS** **c16**
Robert T. Savely and R. Bowen Loftin (Houston Univ., TX.) *In* NASA, Washington, Space Transportation Avionics Technology

Symposium. Volume 2: Conference Proceedings Aug. 1990 p 423-434 (For primary document see N91-17020 09-06)
Avail: NTIS HC/MF A99 CSCL 22B

Training is a major endeavor in all modern societies. Common training methods include training manuals, formal classes, procedural computer programs, simulations, and on-the-job training. NASA's training approach has focussed primarily on on-the-job training in a simulation environment for both crew and ground based personnel. NASA must explore new approaches to training for the 1990's and beyond. Specific autonomous training systems are described which are based on artificial intelligence technology for use by NASA astronauts, flight controllers, and ground based support personnel that show an alternative to current training systems. In addition to these specific systems, the evolution of a general architecture for autonomous intelligent training systems that integrates many of the features of traditional training programs with artificial intelligence techniques is presented. These Intelligent Computer Aided Training (ICAT) systems would provide much of the same experience that could be gained from the best on-the-job training. Author

**N91-17035*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
**ADVANCED AVIONICS CONCEPTS: AUTONOMOUS SPACECRAFT CONTROL** **c16**
*In* NASA, Washington, Space Transportation Avionics Technology Symposium. Volume 2: Conference Proceedings Aug. 1990 p 435-450 (For primary document see N91-17020 09-06)
Avail: NTIS HC/MF A99 CSCL 22B

A large increase in space operations activities is expected because of Space Station Freedom (SSF) and long range Lunar base missions and Mars exploration. Space operations will also increase as a result of space commercialization (especially the increase in satellite networks). It is anticipated that the level of satellite servicing operations will grow tenfold from the current level within the next 20 years. This growth can be sustained only if the cost effectiveness of space operations is improved. Cost effectiveness is operational efficiency with proper effectiveness. A concept is presented of advanced avionics, autonomous spacecraft control, that will enable the desired growth, as well as maintain the cost effectiveness (operational efficiency) in satellite servicing operations. The concept of advanced avionics that allows autonomous spacecraft control is described along with a brief description of each component. Some of the benefits of autonomous operations are also described. A technology utilization breakdown is provided in terms of applications. Author

**N91-17036*#** National Aeronautics and Space Administration, Washington, DC.
**OPERATIONS MANAGEMENT SYSTEM** **c66**
A. E. Brandli, R. E. Eckelkamp, C. M. Kelly, W. McCandless, and D. L. Rue (TRW Electronics and Defense Sector, Redondo Beach, CA.) *In its* Space Transportation Avionics Technology Symposium. Volume 2: Conference Proceedings Aug. 1990 p 451-462 (For primary document see N91-17020 09-06)
Avail: NTIS HC/MF A99 CSCL 12B

The objective of an operations management system is to provide an orderly and efficient method to operate and maintain aerospace vehicles. Concepts are described for an operations management system and the key technologies are highlighted which will be required if this capability is brought to fruition. Without this automation and decision aiding capability, the growing complexity of avionics will result in an unmanageable workload for the operator, ultimately threatening mission success or survivability of the aircraft or space system. The key technologies include expert system application to operational tasks such as replanning, equipment diagnostics and checkout, global system management, and advanced man machine interfaces. The economical development of operations management systems, which are largely software, will require advancements in other technological areas such as software engineering and computer hardware. Author

**N91-17037*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
**OPERATIONAL EFFICIENCY SUBPANEL ADVANCED MISSION CONTROL** **c66**
Peter Friedland *In* NASA, Washington, Space Transportation Avionics Technology Symposium. Volume 2: Conference Proceedings Aug. 1990 p 463-474 (For primary document see N91-17020 09-06)
Avail: NTIS HC/MF A99 CSCL 12B

Herein, the term mission control will be taken quite broadly to include both ground and space based operations as well as the information infrastructure necessary to support such operations. Three major technology areas related to advanced mission control are examined: (1) Intelligent Assistance for Ground-Based Mission Controllers and Space-Based Crews; (2) Autonomous Onboard Monitoring, Control and Fault Detection Isolation and Reconfiguration; and (3) Dynamic Corporate Memory Acquired, Maintained, and Utilized During the Entire Vehicle Life Cycle. The current state of the art space operations are surveyed both within NASA and externally for each of the three technology areas and major objectives are discussed from a user point of view for technology development. Ongoing NASA and other governmental programs are described. An analysis of major research issues and current holes in the program are provided. Several recommendations are presented for enhancing the technology development and insertion process to create advanced mission control environments. Author

**N91-17038*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
**ADVANCED SOFTWARE INTEGRATION: THE CASE FOR ITV FACILITIES** **c61**
John R. Garman *In* NASA, Washington, Space Transportation Avionics Technology Symposium. Volume 2: Conference Proceedings Aug. 1990 p 475-487 (For primary document see N91-17020 09-06)
Avail: NTIS HC/MF A99 CSCL 09B

The array of technologies and methodologies involved in the development and integration of avionics software has moved almost as rapidly as computer technology itself. Future avionics systems involve major advances and risks in the following areas: (1) Complexity; (2) Connectivity; (3) Security; (4) Duration; and (5) Software engineering. From an architectural standpoint, the systems will be much more distributed, involve session-based user interfaces, and have the layered architectures typified in the layers of abstraction concepts popular in networking. Typified in the NASA Space Station Freedom will be the highly distributed nature of software development itself. Systems composed of independent components developed in parallel must be bound by rigid standards and interfaces, the clean requirements and specifications. Avionics software provides a challenge in that it can not be flight tested until the first time it literally flies. It is the binding of requirements for such an integration environment into the advances and risks of future avionics systems that form the basis of the presented concept and the basic Integration, Test, and Verification concept within the development and integration life cycle of Space Station Mission and Avionics systems. Author

**N91-17039*#** National Aeronautics and Space Administration, Washington, DC.
**FLIGHT ELEMENTS: ADVANCED AVIONICS SYSTEMS ARCHITECTURES**
*In its* Space Transportation Avionics Technology Symposium. Volume 2: Conference Proceedings Aug. 1990 p 491-505 (For primary document see N91-17020 09-06)
Avail: NTIS HC/MF A99 CSCL 01D

Space transportation objectives are associated with transporting material from Earth to orbit, interplanetary travel, and planetary landing. The objectives considered herein are associated with Earth to orbit transportation. Many good avionics architectural features will support all phases of space transportation, but interplanetary transportation poses significantly different problems such as long mission time with high reliability, unattended operation, and many

different opportunities such as long nonoperational flight segments that can be used for equipment fault diagnosis and repair. Fault tolerance can be used to permit continued operation with faulty units, not only during launch but also, and perhaps with more impact, during prelaunch activities. Avionics systems are entering a phase of development where the traditional approaches to satisfactory systems based on engineering judgement and thorough testing will alone no longer be adequate to assure that the required system performance can be obtained. A deeper understanding will be required to make the effects of obscure design decisions clear at a level where their impact can be properly judged. Author

**N91-17040*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
**AN ASSESSMENT OF ADVANCED DISPLAYS AND CONTROLS TECHNOLOGY APPLICABLE TO FUTURE SPACE TRANSPORTATION SYSTEMS**
Jack J. Hatfield and Diana Villarreal *In* NASA, Washington, Space Transportation Avionics Technology Symposium. Volume 2: Conference Proceedings Aug. 1990 p 507-520 Prepared in cooperation with NASA, Lyndon B. Johnson Space Center, Houston, TX (For primary document see N91-17020 09-06)
Avail: NTIS HC/MF A99 CSCL 01D

The topic of advanced display and control technology is addressed along with the major objectives of this technology, the current state of the art, major accomplishments, research programs and facilities, future trends, technology issues, space transportation systems applications and projected technology readiness for those applications. The holes that may exist between the technology needs of the transportation systems versus the research that is currently under way are addressed, and cultural changes that might facilitate the incorporation of these advanced technologies into future space transportation systems are recommended. Some of the objectives are to reduce life cycle costs, improve reliability and fault tolerance, use of standards for the incorporation of advancing technology, and reduction of weight, volume and power. Pilot workload can be reduced and the pilot's situational awareness can be improved, which would result in improved flight safety and operating efficiency. This could be accomplished through the use of integrated, electronic pictorial displays, consolidated controls, artificial intelligence, and human centered automation tools. The Orbiter Glass Cockpit Display is an example examined. Author

**N91-17041*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
**ADVANCED SENSORS AND INSTRUMENTATION**
Raymond S. Calloway, Joe E. Zimmerman, Kevin R. Douglas, and Rusty Morrison (Rockwell International Corp., Canoga Park, CA.) *In* NASA, Washington, Space Transportation Avionics Technology Symposium. Volume 2: Conference Proceedings Aug. 1990 p 521-555 (For primary document see N91-17020 09-06)
Avail: NTIS HC/MF A99 CSCL 01D

NASA is currently investigating the readiness of Advanced Sensors and Instrumentation to meet the requirements of new initiatives in space. The following technical objectives and technologies are briefly discussed: smart and nonintrusive sensors; onboard signal and data processing; high capacity and rate adaptive data acquisition systems; onboard computing; high capacity and rate onboard storage; efficient onboard data distribution; high capacity telemetry; ground and flight test support instrumentation; power distribution; and workstations, video/lighting. The requirements for high fidelity data (accuracy, frequency, quantity, spatial resolution) in hostile environments will continue to push the technology developers and users to extend the performance of their products and to develop new generations. Author

**N91-17042*#** National Aeronautics and Space Administration, Washington, DC.
**FLIGHT ELEMENTS: FAULT DETECTION AND FAULT MANAGEMENT** **c38**
H. Lum, A. Patterson-Hine, J. T. Edge, and D. Lawler *In its* Space Transportation Avionics Technology Symposium. Volume 2: Conference Proceedings Aug. 1990 p 557-567 (For primary document see N91-17020 09-06)
Avail: NTIS HC/MF A99 CSCL 09D

Fault management for an intelligent computational system must be developed using a top down integrated engineering approach. An approach proposed includes integrating the overall environment involving sensors and their associated data; design knowledge capture; operations; fault detection, identification, and reconfiguration; testability; causal models including digraph matrix analysis; and overall performance impacts on the hardware and software architecture. Implementation of the concept to achieve a real time intelligent fault detection and management system will be accomplished via the implementation of several objectives, which are: Development of fault tolerant/FDIR requirement and specification from a systems level which will carry through from conceptual design through implementation and mission operations; Implementation of monitoring, diagnosis, and reconfiguration at all system levels providing fault isolation and system integration; Optimize system operations to manage degraded system performance through system integration; and Lower development and operations costs through the implementation of an intelligent real time fault detection and fault management system and an information management system. Author

**N91-17043*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**ADVANCED ELECTRICAL POWER, DISTRIBUTION AND CONTROL FOR THE SPACE TRANSPORTATION SYSTEM** **c33**
Irving G. Hansen and Henry W. Brandhorst, Jr. *In* NASA, Washington, Space Transportation Avionics Technology Symposium. Volume 2: Conference Proceedings Aug. 1990 p 569-579 (For primary document see N91-17020 09-06)
Avail: NTIS HC/MF A99 CSCL 09C

High frequency power distribution and management is a technology ready state of development. As such, a system employs the fewest power conversion steps, and employs zero current switching for those steps. It results in the most efficiency, and lowest total parts system count when equivalent systems are compared. The operating voltage and frequency are application specific trade off parameters. However, a 20 kHz Hertz system is suitable for wide range systems. Author

**N91-17044*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
**IN-FLIGHT CREW TRAINING** **c53**
Charles Gott, Peter Galicki, and David Shores (Barrios Technology, Inc., Houston, TX.) *In* NASA, Washington, Space Transportation Avionics Technology Symposium. Volume 2: Conference Proceedings Aug. 1990 p 581-588 (For primary document see N91-17020 09-06)
Avail: NTIS HC/MF A99 CSCL 05I

The Helmet Mounted Display system and Part Task Trainer are two projects currently underway that are closely related to the in-flight crew training concept. The first project is a training simulator and an engineering analysis tool. The simulator's unique helmet mounted display actually projects the wearer into the simulated environment of 3-D space. Miniature monitors are mounted in front of the wearers eyes. Partial Task Trainer is a kinematic simulator for the Shuttle Remote Manipulator System. The simulator consists of a high end graphics workstation with a high resolution color screen and a number of input peripherals that create a functional equivalent of the RMS control panel in the back of the Orbiter. It is being used in the training cycle for Shuttle crew members. Activities are underway to expand the capability of the Helmet Display System and the Partial Task Trainer. Author

**N91-17045*#** National Aeronautics and Space Administration, Washington, DC.
**NSTS OPERATIONS UTILIZATION DIRECTORATE** **c66**
John Morian *In its* Space Transportation Avionics Technology Symposium. Volume 2: Conference Proceedings Aug. 1990

p 591-636 (For primary document see N91-17020 09-06)
Avail: NTIS HC/MF A99 CSCL 12B

A basic understanding is provided of the National Space Transportation System payload processing operations performed at NASA-Kennedy. The payload facilities, support services, and ground support equipment used to support that process are described. Author

**N91-17046*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
**PAYLOAD ACCOMMODATIONS. AVIONICS PAYLOAD SUPPORT ARCHITECTURE**
Susan L. Creasy and C. D. Levy *In* NASA, Washington, Space Transportation Avionics Technology Symposium. Volume 2: Conference Proceedings Aug. 1990 p 637-644 (For primary document see N91-17020 09-06)
Avail: NTIS HC/MF A99 CSCL 01D

Concepts for vehicle and payload avionics architectures for future NASA programs, including the Assured Shuttle Access program, Space Station Freedom (SSF), Shuttle-C, Advanced Manned Launch System (AMLS), and the Lunar/Mars programs are discussed. Emphasis is on the potential available to increase payload services which will be required in the future, while decreasing the operational cost/complexity by utilizing state of the art advanced avionics systems and a distributed processing architecture. Also addressed are the trade studies required to determine the optimal degree of vehicle (NASA) to payload (customer) separation and the ramifications of these decisions. Author

**N91-17047*#** TRW Defense Systems Group, Houston, TX.
**PAYLOAD ACCOMMODATIONS. SATELLITE SERVICING SUPPORT** **c16**
Roscoe Lee *In* NASA, Washington, Space Transportation Avionics Technolody Symposium. Volume 2: Conference Proceedings Aug. 1990 p 647-656 (For primary document see N91-17020 09-06)
Avail: NTIS HC/MF A99 CSCL 22B

The proposed technology studies discussed at the Space Transportation Avionics Symposium in Williamsburg, VA on 7 to 9 November 1989, are discussed. The discussions and findings of the Payload Accommodations Subpanel are also summarized. The major objective of the proposed focused technology development is to develop and demonstrate (ground and flight) autonomous rendezvous, proximity operations, and docking/berthing capabilities to support satellite servicing. It is expected that autonomous rendezvous and docking (AR and D) capabilities will benefit both the users (e.g., satellite developers and operators) and the transportation system developers and operators. AR and D will provide increased availability of rendezvous and docking services by reducing the operational constraints associated with current capabilities. These constraints include specific lighting conditions, continuous space-to-ground communications, and lengthy ground tracking periods. AR and D will provide increased cost efficiency with the potential for reduced propellant expenditures and workloads (flight and/or ground crews). The AR and D operations will be more consistent, allowing more flexibility in the design of the satellite control system and docking/berthing mechanisms. Author

**N91-17048*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
**PAYLOAD DEPLOYMENT SYSTEMS AND ADVANCED MANIPULATORS** **c54**
*In* NASA, Washington, Space Transportation Avionics Technology Symposium. Volume 2: Conference Proceedings Aug. 1990 p 657-662 (For primary document see N91-17020 09-06)
Avail: NTIS HC/MF A99 CSCL 05H

The results of discussions on future development of avionics to support payload deployment systems and advanced manipulators are discussed. The discussions summarized here were held during the Space Transportation Avionics Technology Symposium in Williamsburg, Virginia on November 7 to 9, 1989. Symposium participants agreed that this subpanel would have benefitted from more participation by users. It was suggested that inputs from Shuttle payload users should be incorporated, either by direct discussions with users or by incorporating comments from users as kept by Payload Accommodations. The Jet Propulsion Laboratory (JPL), Goddard, and Langley, as builders of payloads, and the Space Station Utilization Office could also provide useful inputs. Other potential users for future systems should also be identified as early as possible to determine what they anticipate their needs to be. Symposium participants also recognized that payload deployment is normally not a safety critical area, and as such, is vulnerable to budget cuts that defer costs from development to operations. This does give opportunities for upgrades of operational systems, but these must be very cost effective to compete with vehicle requirements that enhance safety or increase lifetime. Author

**N91-17049*#** National Aeronautics and Space Administration, Washington, DC.
**ADVANCED TELEMETRY SYSTEMS FOR PAYLOADS. TECHNOLOGY NEEDS, OBJECTIVES AND ISSUES** **c17**
*In its* Space Transportation Avionics Technology Symposium. Volume 2: Conference Proceedings Aug. 1990 p 663-671 (For primary document see N91-17020 09-06)
Avail: NTIS HC/MF A99 CSCL 09F

The current trends in advanced payload telemetry are the new developments in advanced modulation/coding, the applications of intelligent techniques, data distribution processing, and advanced signal processing methodologies. Concerted efforts will be required to design ultra-reliable man-rated software to cope with these applications. The intelligence embedded and distributed throughout various segments of the telemetry system will need to be overridden by an operator in case of life-threatening situations, making it a real-time integration issue. Suitable MIL standards on physical interfaces and protocols will be adopted to suit the payload telemetry system. New technologies and techniques will be developed for fast retrieval of mass data. Currently, these technology issues are being addressed to provide more efficient, reliable, and reconfigurable systems. There is a need, however, to change the operation culture. The current role of NASA as a leader in developing all the new innovative hardware should be altered to save both time and money. We should use all the available hardware/software developed by the industry and use the existing standards rather than inventing our own. Author

**N91-17050*#** National Aeronautics and Space Administration, Washington, DC.
**AVIONICS ADVANCED DEVELOPMENT STRATEGY**
D. Dyer *In its* Space Transportation Avionics Technology Symposium. Volume 2: Conference Proceedings Aug. 1990 p 675-686 (For primary document see N91-17020 09-06)
Avail: NTIS HC/MF A99 CSCL 01D

Discussed here is the problem of how to put together an integrated, phased, and affordable avionics advanced development program that links and applies to operational, evolving, and developing programs/vehicles, as well as those in the planning phases. Collecting technology needs from individual programs/vehicles and proposed technology items from individual developers usually results in a mismatch and something that is unaffordable. A strategy to address this problem is outlined with task definitions which will lead to avionics advanced development items that will fit within an overall framework, prioritized to support budgeting, and support the scope of NASA space transportations needs. Author

**N91-17051*#** Lockheed Missiles and Space Co., Sunnyvale, CA.
**RISK ANALYSIS AND MANAGEMENT** **c81**
H. E. Smith *In* NASA, Washington, Space Transportation Avionics Technology Symposium. Volume 2: Conference Proceedigs Aug. 1990 p 687-694 (For primary document see N91-17020 09-06)
Avail: NTIS HC/MF A99 CSCL 05A

Present software development accomplishments are indicative of the emerging interest in and increasing efforts to provide risk assessment backbone tools in the manned spacecraft engineering community. There are indications that similar efforts are underway in the chemical processes industry and are probably being planned for other high risk ground base environments. It appears that complex flight systems intended for extended manned planetary exploration will drive this technology. Author

**N91-17052*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
**SYSTEMS ENGINEERING AND INTEGRATION: COST ESTIMATION AND BENEFITS ANALYSIS** **c83**
Ed Dean, Ernie Fridge, and Joe Hamaker (National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.) *In* NASA, Washington, Space Transportation Avionics Technology Symposium. Volume 2: Conference Proceedings Aug. 1990 p 695-699 (For primary document see N91-17020 09-06)
Avail: NTIS HC/MF A99 CSCL 05C

Space Transportation Avionics hardware and software cost has traditionally been estimated in Phase A and B using cost techniques which predict cost as a function of various cost predictive variables such as weight, lines of code, functions to be performed, quantities of test hardware, quantities of flight hardware, design and development heritage, complexity, etc. The output of such analyses has been life cycle costs, economic benefits and related data. The major objectives of Cost Estimation and Benefits analysis are twofold: (1) to play a role in the evaluation of potential new space transportation avionics technologies, and (2) to benefit from emerging technological innovations. Both aspects of cost estimation and technology are discussed here. The role of cost analysis in the evaluation of potential technologies should be one of offering additional quantitative and qualitative information to aid decision-making. The cost analyses process needs to be fully integrated into the design process in such a way that cost trades, optimizations and sensitivities are understood. Current hardware cost models tend to primarily use weights, functional specifications, quantities, design heritage and complexity as metrics to predict cost. Software models mostly use functionality, volume of code, heritage and complexity as cost descriptive variables. Basic research needs to be initiated to develop metrics more responsive to the trades which are required for future launch vehicle avionics systems. These would include cost estimating capabilities that are sensitive to technological innovations such as improved materials and fabrication processes, computer aided design and manufacturing, self checkout and many others. In addition to basic cost estimating improvements, the process must be sensitive to the fact that no cost estimate can be quoted without also quoting a confidence associated with the estimate. In order to achieve this, better cost risk evaluation techniques are needed as well as improved usage of risk data by decision-makers. More and better ways to display and communicate cost and cost risk to management are required. Author

**N91-17053*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
**SE AND I SYSTEM TESTABILITY: THE KEY TO SPACE SYSTEM FDIR AND VERIFICATION TESTING** **c16**
Thomas Barry, Terrance Scheffer, Lynn R. Small, and Richard Monis (Harris Corp., Syosset, NY.) *In* NASA, Washington, Space Transportation Avionics Technology Symposium. Volume 2: Conference Proceedings Aug. 1990 p 701-706 (For primary document see N91-17020 09-06)
Avail: NTIS HC/MF A99 CSCL 22B

The key to implementing self-diagnosing design is a systems engineering task focused on design for testability concurrent with design for functionality. The design for testability process described here is the product of several years of DOD study and experience. Its application to the space station has begun on Work Package II under NASA and McDonnell direction. Other work package teams are being briefed by Harris Corporation with the hope of convincing them to embrace the process. For the purpose of this discussion the term testability is used to describe the systems engineering process by which designers can assure themselves and their reviewers that their designs are TESTABLE, that is they will support the downstream process of determining their functionality. Due to the complexity and density of present-day state-of-the-art designs, such as pipeline processors and high-speed integrated circuit technology, testability feature design is a critical requirement of the functional design process. A systematic approach to Space systems test and checkout as well as fault detection fault isolation reconfiguration (FDFIR) will minimize operational costs and maximize operational efficiency. An effective design for the testability program must be implemented by all contractors to insure meeting this objective. The process is well understood and technology is here to support it. Author

**N91-17054*#** National Aeronautics and Space Administration, Washington, DC.
**SYSTEMS ENGINEERING AND INTEGRATION: ADVANCED AVIONICS LABORATORIES**
*In its* Space Transportation Avionics Technology Symposium. Volume 2: Conference Proceedings Aug. 1990 p 707-722 (For primary document see N91-17020 09-06)
Avail: NTIS HC/MF A99 CSCL 01D

In order to develop the new generation of avionics which will be necessary for upcoming programs such as the Lunar/Mars Initiative, Advanced Launch System, and the National Aerospace Plane, new Advanced Avionics Laboratories are required. To minimize costs and maximize benefits, these laboratories should be capable of supporting multiple avionics development efforts at a single location, and should be of a common design to support and encourage data sharing. Recent technological advances provide the capability of letting the designer or analyst perform simulations and testing in an environment similar to his engineering environment and these features should be incorporated into the new laboratories. Existing and emerging hardware and software standards must be incorporated wherever possible to provide additional cost savings and compatibility. Special care must be taken to design the laboratories such that real-time hardware-in-the-loop performance is not sacrificed in the pursuit of these goals. A special program-independent funding source should be identified for the development of Advanced Avionics Laboratories as resources supporting a wide range of upcoming NASA programs. Author

**N91-17055*#** National Aeronautics and Space Administration, Washington, DC.
**OPERATIONAL EFFICIENCY** **c66**
Dan Bland, Tom Davis (National Aeronautics and Space Administration. John F. Kennedy Space Center, Cocoa Beach, FL.), and Sandy Griffin *In its* Space Transportation Avionics Technology Symposium. Volume 2: Conference Proceedings Aug. 1990 p 727-750 (For primary document see N91-17020 09-06)
Avail: NTIS HC/MF A99 CSCL 12B

Space transportation avionics technology operational efficiency issues are presented in viewgraph form. Information is given on ascent flight design, autonomous spacecraft control, operations management systems, advanced mission control, telerobotics/telepresence, advanced software integration, advanced test/checkout systems, advanced training systems, and systems monitoring. Author

**N91-17056*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
**FLIGHT ELEMENTS SUBPANEL** **c16**
Claude R. Keckler *In* NASA, Washington, Space Transportation Avionics Technology Symposium. Volume 2: Conference Proceedings Aug. 1990 p 751-778 (For primary document see N91-17020 09-06)
Avail: NTIS HC/MF A99 CSCL 22B

A summary of findings of the Flight Elements Subpanel is given in viewgraph form. Topics covered include advanced avionics architecture; processors; integrated Global Positioning System and

guidance, navigation and control; displays and controls; telemetry; sensors and instrumentation; fault detection and management; electrical power distribution and control; spacecraft power supplies; and in-flight crew training. Author

**N91-17057*#** National Aeronautics and Space Administration, Washington, DC.
**PAYLOAD ACCOMMODATIONS** **c16**
*In its* Space Transportation Avionics Technology Symposium. Volume 2: Conference Proceedings Aug. 1990 p 779-789 (For primary document see N91-17020 09-06)
Avail: NTIS HC/MF A99 CSCL 22B

Payload accommodation topics are presented in viewgraph form. Topics include avionics needs, general observations, payload services, safety, and recommendations. Author

**N91-17058*#** National Aeronautics and Space Administration, Washington, DC.
**SYSTEMS ENGINEERING AND INTEGRATION (SE AND I)** **c16**
*In its* Space Transportation Avionics Technology Symposium. Volume 2: Conference Proceedings Aug. 1990 p 791-800 (For primary document see N91-17020 09-06)
Avail: NTIS HC/MF A99 CSCL 22B

Systems engineering and integration topics are presented in viewgraph form. Requirements, risk, redundancy, standards, costs, tests beds, and operations are covered. Author

**N91-17059#** Naval Weapons Center, China Lake, CA. Dept. of Research.
**PROBING BEHAVIOR IN CERTAIN OPTIMAL PERTURBATION CONTROL LAWS Final Report, Jun. 1989 - Mar. 1990**
Warren W. Willman Jul. 1990 28 p Sponsored by ONR, Arlington, VA
(AD-A229272; AD-E901013; NWC-TP-7081) Avail: NTIS HC/MF A03 CSCL 01/4

Asymptotic approximations of optimal control laws are established for a class of dynamic systems whose state components are either slowly varying (i.e., parameters) or can be tracked arbitrarily well by making the controller's measurements sufficiently accurate. GRA

**N91-17060*#** National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.
**THE EFFECTS OF PRESSURE SENSOR ACOUSTICS ON AIRDATA DERIVED FROM A HIGH-ANGLE-OF-ATTACK FLUSH AIRDATA SENSING (HI-FADS) SYSTEM**
Stephen A. Whitmore and Timothy R. Moes Feb. 1991 23 p Presented at the 29th AIAA Aerospace Sciences Meeting, Reno, NV, 7-10 Jan. 1991 Previously announced in IAA as A91-19404
(NASA-TM-101736; H-1690; NAS 1.15:101736) Avail: NTIS HC/MF A03 CSCL 01D

The accuracy of a nonintrusive high angle-of-attack flush airdata sensing (HI-FADS) system was verified for quasi-steady flight conditions up to 55 deg angle of attack during the F-18 High Alpha Research Vehicle (HARV) Program. The system is a matrix of nine pressure ports arranged in annular rings on the aircraft nose. The complete airdata set is estimated using nonlinear regression. Satisfactory frequency response was verified to the system Nyquist frequency (12.5 Hz). The effects of acoustical distortions within the individual pressure sensors of the nonintrusive pressure matrix on overall system performance are addressed. To quantify these effects, a frequency-response model describing the dynamics of acoustical distortion is developed and simple design criteria are derived. The model adjusts measured HI-FADS pressure data for the acoustical distortion and quantifies the effects of internal sensor geometries on system performance. Analysis results indicate that sensor frequency response characteristics very greatly with altitude, thus it is difficult to select satisfactory sensor geometry for all altitudes. The solution used presample filtering to eliminate resonance effects, and short pneumatic tubing sections to reduce lag effects. Without presample signal conditioning the system designer must use the pneumatic transmission line to attenuate the resonances and accept the resulting altitude variability. Author

**N91-17560*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
**DIGITAL AVIONICS: A CORNERSTONE OF AVIATION**
Cary R. Spitzer *In its* NASA Formal Methods Workshop, 1990 Nov. 1990 24 p (For primary document see N91-17559 09-61)
Avail: NTIS HC/MF A22 CSCL 09B

# 07 AIRCRAFT PROPULSION AND POWER

Includes prime propulsion systems and systems components, e.g., gas turbine engines and compressors; and onboard auxilliary power plants for aircraft.

For related information see also *20 Spacecraft Propulsion and Power, 28 Propellants and Fuels,* and *44 Energy Production and Conversion.*

**N91-17061** Oxford Univ. (England).
**AERODYNAMIC AND MECHANICAL PERFORMANCE OF A HIGH-PRESSURE TURBINE STAGE IN A TRANSIENT WIND TUNNEL Ph.D. Thesis**
A. G. Sheard 1989 279 p
Avail: Univ. Microfilms Order No. BRD-90358

The effects of unsteady and three dimensional flow phenomena are recognized as having a major effect on the aerodynamic performance of, and heat transfer to, gas turbine blading. Studying the mechanisms associated with these phenomena requires an experimental facility capable of simulating the environment found in a gas turbine, but at lower total temperature and pressure levels, to allow the use of conventional measurement techniques. This work centers about the design, development, and commissioning of a new experimental facility consisting of a 62 percent size high pressure gas turbine stage mounted in a transient wind tunnel. The new facility provides the required simulation of the turbine design point in a full stage turbine; therefore, it models the unsteady and three dimensional flow phenomena which are the focus of interest. The aerodynamic and mechanical design of the new facility are presented, as is a rigorous stress analysis of the facility's rotating system. The three stage commissioning of the facility is described, concluding with an assessment of the turbine stage performance. Author

# 08 AIRCRAFT STABILITY AND CONTROL

Includes aircraft handling qualities; piloting; flight controls; and autopilots.

For related information see also *05 Aircraft Design, Testing and Performance.*

**N91-17062#** Ballistic Research Labs., Aberdeen Proving Ground, MD.
**A SYMPTOM OF PAYLOAD-INDUCED FLIGHT INSTABILITY Final Report, Dec. 1986 - Sep. 1990**
Charles H. Murphy Sep. 1990 17 p
(DA Proj. 1L1-62618-AH-80)
(AD-A227515; BRL-MR-3867) Avail: NTIS HC/MF A03 CSCL 19/10

Observations of instability caused by a moving payload (liquid or solid) have shown that large angular motions are always accompanied by a large spin-down moment. A simple general relation is derived between the side moment and the spin moment caused by the steady-state motion of any movable payload. GRA

**N91-17063** Michigan Univ., Ann Arbor.
**TIME-OPTIMAL ATTITUDE CONTROL OF A SPINNING MISSILE Ph.D. Thesis**
Ebad Jahangir 1990 148 p
Avail: Univ. Microfilms Order No. DA9034446

The problem of minimum-time attitude control of a spinning missile is addressed. The missile is modeled as a rigid body which is symmetric about one axis. The missile has a large roll rate about this axis of symmetry. Control is achieved by a single reaction jet which, when fired, provides a constant moment about a transverse axis. Disturbance torques are assumed to be zero. The equations of motion are written under these assumptions. The missile is assumed to have some arbitrary initial transverse angular velocity and it is desired to take it to some final attitude in minimum time while reducing the transverse angular velocity to zero. This problem is formulated as an optimal control problem. The solution of this problem involves integrating ten nonlinear equations with split boundary conditions and an unknown final time. Instead of taking this arduous route which requires solving a two point boundary value problem, two alternative approaches are considered. The first approach deals with the specific case where only two thruster firings are needed to change the attitude of the missile. This approach involves iterations on the switch times and integration of only the state equations. In this way, the thruster firing times are obtained for a given set of boundary conditions. The other approach uses the concept of the set of reachable states. It involves transforming the state variables and integrating the transformed state and costate equations backwards in time and generating the control history using the properties of the optimal control. The control history, given in terms of the thruster firing times, is stored as a function of the boundary conditions. A feedback control law based on function generation is devised which uses only the first thruster turn-on and turn-off times. Some examples are included to illustrate the application of the concepts presented. Dissert. Abstr.

**N91-17064#** Texas A&M Univ., College Station.
**NOVEL DYNAMICS AND CONTROLS ANALYSIS METHODS FOR NONLINEAR STRUCTURAL SYSTEMS Interim Report, 1 Jul. 1989 - 31 Jul. 1990**
J. L. Junkins, A. J. Kurdila, and Z. H. Rahman 30 Aug. 1990 120 p
(Contract F49620-89-C-0084; AF Proj. 2302)
(AD-A229164; AFOSR-90-1077TR) Avail: NTIS HC/MF A06 CSCL 12/4

Significant progress is reported on analytical and computational methodology applicable to dynamics and control of flexible multibody structures. Especially significant are the following: (1) New analytical and numerical results pertaining to imposing constraints were developed in multi-body dynamical modeling and numerical simulation. An extension of existing penalty methods was developed for constrained multibody dynamics, including some significant convergence proofs. (2) A power principle was developed which permits the efficient construction of stabilizing control laws for systems described by nonlinear systems of coupled ordinary and partial differential equations. (3) A study was initiated of symbol manipulation methods to derive polynomial-type nonlinear feedback control laws for dynamical systems with polynomial nonlinearities. A general MACSYMA symbolic computer code has been developed and studies are under way on several test problems. GRA

**N91-17561*#** Boeing Commercial Airplane Co., Seattle, WA.
**LIFE-CRITICAL DIGITAL FLIGHT CONTROL SYSTEMS**
James McWha *In* NASA, Langley Research Center, NASA Formal Methods Workshop, 1990 Nov. 1990 22 p (For primary document see N91-17559 09-61)
Avail: NTIS HC/MF A22 CSCL 01C

**N91-17565*#** SRI International Corp., Menlo Park, CA. Computer Science Lab.
**WHAT FM CAN OFFER DFCS DESIGN**
John Rushby *In* NASA, Langley Research Center, NASA Formal Methods Workshop, 1990 Nov. 1990 30 p (For primary document see N91-17559 09-61)
Avail: NTIS HC/MF A22 CSCL 09B

**N91-17566*#** Computational Logic, Inc., Austin, TX.
**WHAT CAN FORMAL METHODS OFFER TO DIGITAL FLIGHT CONTROL SYSTEMS DESIGN**
Donald I. Good *In* NASA, Langley Research Center, NASA Formal Methods Workshop, 1990 Nov. 1990 38 p (For primary document see N91-17559 09-61)
Avail: NTIS HC/MF A22 CSCL 09B

# 09 RESEARCH AND SUPPORT FACILITIES (AIR)

Includes airports, hangars and runways; aircraft repair and overhaul facilities; wind tunnels; shock tubes; and aircraft engine test stands.

For related information see also *14 Ground Support Systems and Facilities (Space).*

**N91-17065*#** Virginia Polytechnic Inst. and State Univ., Blacksburg. Center for Transportation Research.
**RUNWAY EXIT DESIGNS FOR CAPACITY IMPROVEMENT DEMONSTRATIONS. PHASE 1: ALGORITHM DEVELOPMENT**
A. A. Trani, A. G. Hobeika, H. Sherali, B. J. Kim, and C. K. Sadam Jun. 1990 166 p Sponsored by FAA, Washington, DC
(Contract NAS1-18471)
(NASA-CR-187955; NAS 1.26:187955; CTR-R-1-90-PHASE-1; DOT/FAA/RD-90/32-PHASE-1) Avail: NTIS HC/MF A08 CSCL 01E

A description and results are presented of a study to locate and design rapid runway exits under realistic airport conditions. The study developed a PC-based computer simulation-optimization program called REDIM (runway exit design interactive model) to help future airport designers and planners to locate optimal exits under various airport conditions. The model addresses three sets of problems typically arising during runway exit design evaluations. These are the evaluations of existing runway configurations, addition of new rapid runway turnoffs, and the design of new runway facilities. The model is highly interactive and allows a quick estimation of the expected value of runway occupancy time. Aircraft populations and airport environmental conditions are among the multiple inputs to the model to execute a viable runway location and geometric design solution. The results presented suggest that possible reductions on runway occupancy time (ROT) can be achieved with the use of optimally tailored rapid runway designs for a given aircraft population. Reductions of up to 9 to 6 seconds are possible with the implementation of 30 m/sec variable geometry exits. Author

**N91-17066#** Ballistic Research Labs., Aberdeen Proving Ground, MD. Blast Dynamics Branch.
**COMPUTATIONAL STUDIES FOR 1/57-SCALE LARGE BLAST SIMULATOR (LBS) CONFIGURATIONS WITH THE BLAST2D CODE Final Report, Jan. 1988 - Jan. 1990**
Dixie M. Hisley Sep. 1990 38 p
(DA Proj. 1L1-62120-AH-25)
(AD-A227514; BRL-TR-3152) Avail: NTIS HC/MF A03 CSCL 12/5

One of the continuing research efforts of the Blast Dynamics Branch at the U.S. Army Ballistic Research Laboratory (BRL) is to simulate the flow that results from nuclear explosions and to test the nuclear survivability of military equipment. When atmospheric nuclear blast tests were banned, chemical explosive tests were designed and conducted to simulate the blast and thermal pulses produced by real nuclear explosions. These full-scale tests provided data for analysis of nuclear survivability to tactical Army equipment. However, the logistics and expense of full-scale chemical explosive tests meant that an average of only one test could be conducted every two years. A series of computational simulations are

performed for comparison to experimental data from a 1/57 -scale Large Blast Simulator (LBS) experimental shock tube. The computations simulate experiments with various high pressure and temperature initial driver gas conditions. In addition to temperature and pressure variations, geometry and numerical accuracy variation are performed and studied. The computations were performed using an axisymmetric, inviscid, time-accurate, finite-volume numerical technique which employs upwind flux differencing with total variation diminishing techniques. Computational results are presented in the form of static and stagnation pressure versus time histories and contour plots. GRA

**N91-17067#** North Carolina Univ., Research Triangle Park. Inst. for Transportation Research and Education.
**PAVEMENT MARKING MATERIALS PROGRAM Final Report, Jul. 1987 - Jun. 1989**
R. W. Attaway and P. O. Adeleke-Sheidun Jan. 1990 245 p Sponsored in part by Federal Highway Administration; and North Carolina State Dept. of Transportation
(PB90-264615; FHWA/NC-89/005) Avail: NTIS HC/MF A11 CSCL 14B

A wide range of issues dealing with pavement markings is covered: reflectivity levels and visibility requirements, test deck evaluations, in-service testing, pre-mixed versus plain traffic paint performance, water base paints, and durable marking materials. Evaluations also included permanent and temporary removable tapes. Author

**N91-17068*#** Essex Corp., Huntsville, AL.
**THE DESIGN AND DEVELOPMENT OF THE HUBBLE SPACE TELESCOPE NEUTRAL BUOYANCY TRAINER Final Report, Mar. 1983 - Dec. 1990**
31 Dec. 1990 14 p
(Contract NAS8-35318)
(NASA-CR-184094; NAS 1.26:184094) Avail: NTIS HC/MF A03 CSCL 14B

The design and fabrication of Hubble Space Telescope (HST) Extra Vehicular Activity (EVA) training hardware for zero-gravity simulations in the Marshall Space Flight Center Neutral Buoyancy Simulator (NBS) are discussed. The HST NBS hardware was also used to support flight hardware development and development of EVA crew servicing procedures. The design and fabrication of simulator training and development hardware, the associated test support from utility divers, test conductors, and test subjects have all been with the common goal of enabling HST program management to use NBS EVA data to make design and program decisions. Y.S.

**N91-17069*#** Institute for Computer Applications in Science and Engineering, Hampton, VA.
**TRANSIENT, HYPERVELOCITY FLOW IN AN AXISYMMETRIC NOZZLE Final Report**
P. A. Jacobs Jan. 1991 52 p Previously announced in IAA as A91-19223 Submitted for publication
(Contract NAS1-18605)
(NASA-CR-187496; ICASE-91-1; NAS 1.26:187496) Avail: NTIS HC/MF A04 CSCL 14B

The performance of an axisymmetric nozzle was examined which was designed to produce uniform, parallel flow with a nominal Mach number of 8. A free-piston driven shock tube was used to supply the nozzle with high-temperature, high-pressure test gas. Performance was assessed by measuring Pitot pressures across the exit plane of the nozzle and, over the range of operating conditions examined, the nozzle produced satisfactory test flows. However, there were flow disturbances that persisted for significant times after flow initiation. The detailed starting process of the nozzle was also investigated by performing numerical simulations at several nominal test conditions. The classical description of the starting process, based on a quasi-one-dimensional model, provided a reasonable approximation and was used to demonstrate that the starting process could consume a significant fraction of the otherwise usable test gas. This was especially important at high operating enthalpies where nozzle supply conditions were maintained for shorter times. Multidimensional simulations illustrated a mechanism by which the starting process in the actual nozzle could take longer than that predicted by the quasi-one-dimensional analysis. However, the cause of the persistent disturbances observed in the experimental calibration was not identified. Author

# 12 ASTRONAUTICS (GENERAL)

For extraterrestrial exploration see *91 Lunar and Planetary Exploration.*

**N91-17070#** Joint Publications Research Service, Arlington, VA.
**JPRS REPORT. SCIENCE AND TECHNOLOGY. USSR: SPACE**
5 Oct. 1990 71 p Transl. into ENGLISH from various Russian articles
(JPRS-USP-90-004) Avail: NTIS HC/MF A04

U.S.S.R. space science activities are summarized. Manned mission highlights, interplanetary sciences, space engineering, space applications, and space policy and administration topics are covered. Author

**N91-17071*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
**A TRAJECTORY PLANNING SCHEME FOR SPACECRAFT IN THE SPACE STATION ENVIRONMENT M.S. Thesis - University of California**
Jeffrey Alan Soller, Arthur J. Grunwald, and Stephen R. Ellis Jan. 1991 56 p
(NASA-TM-102866; A-90287; NAS 1.15:102866) Avail: NTIS HC/MF A04 CSCL 22A

Simulated annealing is used to solve a minimum fuel trajectory problem in the space station environment. The environment is special because the space station will define a multivehicle environment in space. The optimization surface is a complex nonlinear function of the initial conditions of the chase and target crafts. Small permutations in the input conditions can result in abrupt changes to the optimization surface. Since no prior knowledge about the number or location of local minima on the surface is available, the optimization must be capable of functioning on a multimodal surface. It was reported in the literature that the simulated annealing algorithm is more effective on such surfaces than descent techniques using random starting points. The simulated annealing optimization was found to be capable of identifying a minimum fuel, two-burn trajectory subject to four constraints which are integrated into the optimization using a barrier method. The computations required to solve the optimization are fast enough that missions could be planned on board the space station. Potential applications for on board planning of missions are numerous. Future research topics may include optimal planning of multi-waypoint maneuvers using a knowledge base to guide the optimization, and a study aimed at developing robust annealing schedules for potential on board missions. Author

**N91-17072#** Edgerton, Germeshausen and Grier, Inc., Idaho Falls, ID.
**ATOMS FOR SPACE**
David Buden Oct. 1990 50 p
(Contract DE-AC07-76ID-01570)
(DE91-006294; EGG-CNET-9142) Avail: NTIS HC/MF A03

Nuclear technology offers many advantages in an expanded solar system space exploration program. These cover a range of possible applications such as power for spacecraft, lunar and planetary surfaces, and electric propulsion; rocket propulsion for lunar and Mars vehicles; space radiation protection; water and sewage treatment; space mining; process heat; medical isotopes; and self-luminous systems. In addition, space offers opportunities to perform scientific research and develop systems that can solve problems here on Earth. These might include fusion and antimatter research, using the Moon as a source of helium-3 fusion fuel, and manufacturing perfect fusion targets. In addition, nuclear

technologies can be used to reduce risk and costs of the Space Exploration Initiative. DOE

**N91-17027*#** National Aeronautics and Space Administration, Washington, DC.
**EXPLORATION INITIATIVES: POST-APOLLO MANNED SPACEFLIGHT THRUSTS**
*In its* Space Transportation Avionics Technology Symposium. Volume 2: Conference Proceedings Aug. 1990 p 229-246 (For primary document see N91-17020 09-06)
Avail: NTIS HC/MF A99 CSCL 22A

# 13 ASTRODYNAMICS

Includes powered and free-flight trajectories; and orbital and launching dynamics.

**N91-17073*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
**FLIGHT MECHANICS/ESTIMATION THEORY SYMPOSIUM, 1990**
Thomas Stengle, ed. Dec. 1990 549 p Symposium held in Greenbelt, MD, 22-24 May 1990
(NASA-CP-3102; REPT-91B00018; NAS 1.55:3102) Avail: NTIS HC/MF A23 CSCL 22A

This conference publication includes 32 papers and abstracts presented at the Flight Mechanics/Estimation Theory Symposium on May 22-25, 1990. Sponsored by the Flight Dynamics Division of Goddard Space Flight Center, this symposium features technical papers on a wide range of issues related to orbit-attitude prediction, determination and control; attitude sensor calibration; attitude determination error analysis; attitude dynamics; and orbit decay and maneuver strategy. Government, industry, and the academic community participated in the preparation and presentation of these papers. For individual titles, see N91-17074 through N91-17105.

**N91-17074*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
**COMPARISON OF TWO ON-ORBIT ATTITUDE SENSOR ALIGNMENT METHODS**
Kenneth Krack, Michael Lambertson (Computer Sciences Corp., Lanham, MD.), and F. Landis Markley *In its* Flight Mechanics/Estimation Theory Symposium, 1990 Dec. 1990 p 3-20 (For primary document see N91-17073 09-13)
Avail: NTIS HC/MF A23 CSCL 22A

Compared here are two methods of on-orbit alignment of vector attitude sensors. The first method uses the angular difference between simultaneous measurements from two or more sensors. These angles are compared to the angular differences between the respective reference positions of the sensed objects. The alignments of the sensors are adjusted to minimize the difference between the two sets of angles. In the second method, the sensor alignment is part of a state vector that includes the attitude. The alignments are adjusted along with the attitude to minimize all observation residuals. It is shown that the latter method can result in much less alignment uncertainty when gyroscopes are used for attitude propagation during the alignment estimation. The additional information for this increased accuracy comes from knowledge of relative attitude obtained from the spacecraft gyroscopes. The theoretical calculations of this difference in accuracy are presented. Also presented are numerical estimates of the alignment uncertainties of the fixed-head star trackers on the Extreme Ultraviolet Explorer spacecraft using both methods. Author

**N91-17075*#** Computer Sciences Corp., Lanham, MD.
**ATTITUDE SENSOR ALIGNMENT CALIBRATION FOR THE SOLAR MAXIMUM MISSION** **c19**
Daniel S. Pitone and Malcolm D. Shuster (Johns Hopkins Univ., Laurel, MD.) *In* NASA, Goddard Space Flight Center, Flight Mechanics/Estimation Theory Symposium, 1990 Dec. 1990 p 21-39 (For primary document see N91-17073 09-13)
Avail: NTIS HC/MF A23 CSCL 22B

An earlier heuristic study of the fine attitude sensors for the Solar Maximum Mission (SMM) revealed a temperature dependence of the alignment about the yaw axis of the pair of fixed-head star trackers relative to the fine pointing Sun sensor. Here, new sensor alignment algorithms which better quantify the dependence of the alignments on the temperature are developed and applied to the SMM data. Comparison with the results from the previous study reveals the limitations of the heuristic approach. In addition, some of the basic assumptions made in the prelaunch analysis of the alignments of the SMM are examined. The results of this work have important consequences for future missions with stringent attitude requirements and where misalignment variations due to variations in the temperature will be significant. Author

**N91-17076*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
**INFLIGHT ESTIMATION OF GYRO NOISE** **c19**
O. H. Filla, T. Z. Willard, D. Chu (Computer Sciences Corp., Lanham, MD.), and Julie Deutschmann *In its* Flight Mechanics/Estimation Theory Symposium, 1990 Dec. 1990 p 41-58 (For primary document see N91-17073 09-13)
(Contract NAS5-31500)
Avail: NTIS HC/MF A23 CSCL 22B

A method is described and demonstrated for estimating single-axis gyro noise levels in terms of the Farrenkopf model parameters. This is accomplished for the Cosmic Background Explorer (COBE) by comparing gyro-propagated attitudes with less accurate single-frame solutions and fitting the squared differences to a third-order polynomial in time. Initial results are consistent with the gyro specifications, and these results are used to determine limits on the duration of batches used to determine attitude. Sources of error are discussed, and guidelines for a more elegant implementation, as part of a batch estimator or filter, are included for future work. Author

**N91-17077*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
**FIXED-HEAD STAR TRACKER MAGNITUDE CALIBRATION ON THE SOLAR MAXIMUM MISSION** **c19**
Daniel S. Pitone, B. J. Twambly, A. H. Eudell, and D. A. Roberts *In its* Flight Mechanics/Estimation Theory Symposium, 1990 Dec. 1990 p 59-78 (For primary document see N91-17073 09-13)
Avail: NTIS HC/MF A23 CSCL 22B

The sensitivity of the fixed-head star trackers (FHSTs) on the Solar Maximum Mission (SMM) is defined as the accuracy of the electronic response to the magnitude of a star in the sensor field-of-view, which is measured as intensity in volts. To identify stars during attitude determination and control processes, a transformation equation is required to convert from star intensity in volts to units of magnitude and vice versa. To maintain high accuracy standards, this transformation is calibrated frequently. A sensitivity index is defined as the observed intensity in volts divided by the predicted intensity in volts; thus, the sensitivity index is a measure of the accuracy of the calibration. Using the sensitivity index, analysis is presented that compares the strengths and weaknesses of two possible transformation equations. The effect on the transformation equations of variables, such as position in the sensor field-of-view, star color, and star magnitude, is investigated. In addition, results are given that evaluate the aging process of each sensor. The results in this work can be used by future missions as an aid to employing data from star cameras as effectively as possible. Author

**N91-17078*#** Computer Sciences Corp., Silver Spring, MD.
**COBE ATTITUDE AS SEEN FROM THE FDF**
J. Sedlak, D. Chu, and E. Scheidker *In* NASA, Goddard Space Flight Center, Flight Mechanics/Estimation Theory Symposium, 1990 Dec. 1990 p 79-96 (For primary document see N91-17073 09-13)

(Contract NAS5-31500)
Avail: NTIS HC/MF A23 CSCL 22A

The goal of the Flight Dynamics Facility (FDF) attitude support is twofold: to determine spacecraft attitude and to explain deviations from nominal attitude behavior. Attitude determination often requires resolving contradictions in the sensor observations. This may be accomplished by applying calibration corrections or by revising the observation models. After accounting for all known sources of error, solution accuracy should be limited only by observation and propagation noise. The second half of the goal is to explain why the attitude may not be as originally intended. Reasons for such deviations include sensor or actuator misalignments and control system performance. In these cases, the ability to explain the behavior should, in principle, be limited only by knowledge of the sensor and actuator data and external torques. Documented here are some results obtained to date in support of the Cosmic Background Explorer (COBE). Advantages and shortcomings of the integrated attitude determination/sensor calibration software are discussed. Some preliminary attitude solutions using data from the Diffuse Infrared Background Experiment (DIRBE) instrument are presented and compared to solutions using Sun and Earth sensors. A dynamical model is constructed to illustrate the relative importance of the various sensor imprefections. This model also shows the connection between the high- and low-frequency attitude oscillations. Author

**N91-17079*#** Computer Sciences Corp., Silver Spring, MD.
**ACCURACY OF THE ERBS DEFINITIVE ATTITUDE DETERMINATION SYSTEM IN THE PRESENCE OF PROPAGATION NOISE**
D. Chu and E. Harvie *In* NASA, Goddard Space Flight Center, Flight Mechanics/Estimation Theory Symposium, 1990 Dec. 1990 p 97-113 (For primary document see N91-17073 09-13)
(Contract NAS5-31500)
Avail: NTIS HC/MF A23 CSCL 22A

Definitive attitude solutions are supposed to be the most accurate possible. For the Earth Radiation Budget Satellite (ERBS), this has been accomplished by using gyro rates to transform many nonsimultaneous observations to a common time point and then averaging to reduce the effects of observation noise. Rate quality is critical to realizing improved accuracy with this method. Gyro deterioration, which shows up as large observation residuals and discontinuities between contiguous batch solutions, now discourages using the batch approach for ERBS. To address this problem, a simple Kalman filter is tried in place of the batch estimator. The filter works well as long as the attitude is completely observable. During periods without Sun coverage, however, the extrapolated yaw may diverge and then change abruptly when the Sun returns to the sensor field of view. Causes of this behavior are discussed, and some solutions are tried that address the observability aspect of the problem. Author

**N91-17080*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**AN ACCURACY ASSESSMENT OF MAGELLAN VERY LONG BASELINE INTERFEROMETRY (VLBI)**
D. B. Engelhardt, G. R. Kronschnabl, and J. S. Border *In* NASA, Goddard Space Flight Center, Flight Mechanics/Estimation Theory Symposium, 1990 Dec. 1990 p 115-132 (For primary document see N91-17073 09-13)
Avail: NTIS HC/MF A23 CSCL 22A

Very Long Baseline Interferometry (VLBI) measurements of the Magellan spacecraft's angular position and velocity were made during July through September, 1989, during the spacecraft's heliocentric flight to Venus. The purpose of this data acquisition and reduction was to verify this data type for operational use before Magellan is inserted into Venus orbit, in August, 1990. The accuracy of these measurements are shown to be within 20 nanoradians in angular position, and within 5 picoradians/sec in angular velocity. The media effects and their calibrations are quantified; the wet fluctuating troposphere is the dominant source of measurement error for angular velocity. The charged particle effect is completely calibrated with S- and X-Band dual-frequency calibrations. Increasing the accuracy of the Earth platform model parameters, by using VLBI-derived tracking station locations consistent with the planetary ephemeris frame, and by including high frequency Earth tidal terms in the Earth rotation model, add a few nanoradians improvement to the angular position measurements. Angular velocity measurements were insensitive to these Earth platform modelling improvements. Author

**N91-17081*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
**JOINT JSC/GSFC TWO-TDRS NAVIGATION CERTIFICATION RESULTS FOR STS-29, STS-30, AND STS-32**
Thomas G. Schmidt, Edward T. Brown, Valerie E. Murdock, James O. Cappellari, Jr., Evan A. Smith, Mark W. Schmitt, James W. OMalley, Flora B. Lowes (National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.), and James B. Joyce *In its* Flight Mechanics/Estimation Theory Symposium, 1990 Dec. 1990 p 133-149 (For primary document see N91-17073 09-13)
(Contracts NAS5-31500; NAS9-18000)
Avail: NTIS HC/MF A23 CSCL 22A

The procedures used and the results obtained in the joint Johnson Space Center (JSC)/Goddard Space Flight Center (GSFC) navigation certification of the two-Tracking and Data Relay Satellite (TDRS) S-band tracking configuration for support of low- to medium-inclination (28.5 to 62 degrees) Shuttle missions (STS-29 and STS-30) and Shuttle rendezvous missions (STS-32) are described. The objective of this certification effort was to certify the two-TDRS configuration for nominal Space Transportation System (STS) on-orbit navigation support, thereby making it possible to significantly reduce the ground tracking support requirements for routine STS on-orbit navigation. JSC had the primary responsibility for certification of the two-TDRS configuration for STS support, and GSFC supported the effort by performing Ground Network (GN) and Space Network (SN) tracking data evaluation, parallel orbit solutions, and solution comparisons. In the certification process, two types of orbit determination solutions were generated by JSC and by GSFC for each tracking arc evaluated, one type using TDRS-East and TDRS-West tracking data combined with ground tracking data (the reference solutions) and one type using only TDRS-East and TDRS-West tracking data. The two types of solutions were then compared to determine the maximum position differences over the solution arcs and whether these differences satisfied the navigation certification criteria. The certification criteria were a function of the type of Shuttle activity in the tracking arc, i.e., quiet, moderate, or active. Quiet periods included no attitude maneuvers or ventings; moderate periods included one or two maneuvers or ventings; and active periods included more than two maneuvers or ventings. The results of the individual JSC and GSFC certification analyses for the STS-29, STS-30, and STS-32 missions and the joint JSC/GSFC conclusions regarding certification of the two-TDRS S-band configuration for STS support are presented. Author

**N91-17082*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
**IONOSPHERIC REFRACTION EFFECTS ON ORBIT DETERMINATION USING THE ORBIT DETERMINATION ERROR ANALYSIS SYSTEM**
C. P. Yee, D. A. Kelbel, T. Lee, J. B. Dunham (Computer Sciences Corp., Greenbelt, MD.), and G. D. Mistretta *In its* Flight Mechanics/Estimation Theory Symposium, 1990 Dec. 1990 p 151-170 (For primary document see N91-17073 09-13)
(Contract NAS5-31500)
Avail: NTIS HC/MF A23 CSCL 22A

The influence of ionospheric refraction on orbit determination was studied through the use of the Orbit Determination Error Analysis System (ODEAS). The results of a study of the orbital state estimate errors due to the ionospheric refraction corrections, particularly for measurements involving spacecraft-to-spacecraft tracking links, are presented. In current operational practice at the Goddard Space Flight Center (GSFC) Flight Dynamics Facility (FDF), the ionospheric refraction effects on the tracking

measurements are modeled in the Goddard Trajectory Determination System (GTDS) using the Bent ionospheric model. While GTDS has the capability of incorporating the ionospheric refraction effects for measurements involving ground-to-spacecraft tracking links, such as those generated by the Ground Spaceflight Tracking and Data Network (GSTDN), it does not have the capability to incorporate the refraction effects for spacecraft-to-spacecraft tracking links for measurements generated by the Tracking and Data Relay Satellite System (TDRSS). The lack of this particular capability in GTDS raised some concern about the achievable accuracy of the estimated orbit for certain classes of spacecraft missions that require high-precision orbits. Using an enhanced research version of GTDS, some efforts have already been made to assess the importance of the spacecraft-to-spacecraft ionospheric refraction corrections in an orbit determination process. While these studies were performed using simulated data or real tracking data in definitive orbit determination modes, the study results presented here were obtained by means of covariance analysis simulating the weighted least-squares method used in orbit determination. Author

**N91-17083*#** Computer Sciences Corp., Beltsville, MD.
**A COMPARISON OF OPERATIONALLY DETERMINED ATMOSPHERIC DENSITIES FROM SATELLITE ORBIT SOLUTIONS AND THE EXOSPHERIC TEMPERATURE FROM THE JACCHIA-ROBERTS MODEL**
D. T. Ward, E. A. Smith, and M. C. Phenneger *In* NASA, Goddard Space Flight Center, Flight Mechanics/Estimation Theory Symposium, 1990 Dec. 1990 p 171-187 (For primary document see N91-17073 09-13)
(Contract NAS5-31500)
Avail: NTIS HC/MF A23 CSCL 22A

Operational orbit determination by the Flight Dynamics Division at the Goddard Space Flight Center has yielded a data base of orbit solutions covering the onset of solar cycle 22. Solutions for nine satellites include an estimated drag adjustment parameter (rho sub 1) determined by the Goddard Trajectory Determination System (GTDS). The rho sub 1 is used to evaluate correlations between density variations and changes in the following: 10.7-centimeter wavelength solar flux (F sub 10.7), the geomagnetic index A sub p, and two exospheric temperatures (T sub c and T sub infinity) adapted from the Jacchia-Roberts atmospheric density model in GTDS. T sub c depends on the daily and 81-day centered mean F sub 10.7; T sub infinity depends on T sub c and the geomagnetic index K sub p values. The highest correlations are between density and T sub infinity. Correlations with T sub c and F sub 10.7 are lower by 9 and 10 percent, respectively. For most cases, correlations with A sub p are considerably lower; however, significant correlations with A sub p were found for some high-inclination, moderate-altitude orbits. Results from this analysis enhance the understanding of the drag model and the accommodation of atmospheric density variations in the operational orbit determination support. The degree of correlation demonstrates the sensitivity of the orbit determination process to drag variations and to the input parameters that characterize aspects of the atmospheric density model. To this extent, the degree of correlation provides a measure of performance for methods of selecting or modeling the thermospheric densities using the solar F sub 10.7 and geomagnetic data as input to the process. Author

**N91-17084*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
**PROCEDURES FOR MINIMIZING THE EFFECTS OF HIGH SOLAR ACTIVITY ON SATELLITE TRACKING AND EPHEMERIS GENERATION**
Gordon D. Bredvik *In its* Flight Mechanics/Estimation Theory Symposium, 1990 Dec. 1990 p 189-196 (For primary document see N91-17073 09-13)
Avail: NTIS HC/MF A23 CSCL 22A

We are currently experiencing a period of high solar radiation combined with wide short-term fluctuations in the radiation. The short-term fluctuations, especially when combined with highly energetic solar flares, can adversely affect the mission of U.S. Space Command's Space Surveillance Center (SSC) which catalogs and tracks the satellites in orbit around the Earth. Rapidly increasing levels of solar electromagnetic and/or particle radiation (solar wind) causes atmospheric warming, which, in turn, causes the upper-most portions of the atmosphere to expand outward, into the regime of low altitude satellites. The increased drag on satellites from this expansion can cause large, unmodeled, in-track displacements, thus undermining the SSC's ability to track and predict satellite position. On 13 March 1989, high solar radiation levels, combined with a high-energy solar flare, caused an exceptional amount of short-term atmospheric warming. The SSC temporarily lost track of over 1300 low altitude satellites--nearly half of the low altitude satellite population. Observational data on satellites that became lost during the days following the 13 March 'solar event' was analyzed and compared with the satellites' last element set prior to the event (referred to as a geomagnetic storm because of the large increase in magnetic flux in the upper atmosphere). The analysis led to a set of procedures for reducing the impact of future geomagnetic storms. These procedures adjust selected software limit parameters in the differential correction of element sets and in the observation association process and must be manually initiated at the onset of a geomagnetic storm. Sensor tasking procedures must be adjusted to ensure that a minimum of four observations per day are received for low altitude satellites. These procedures have been implemented and, thus far, appear to be successful in minimizing the effect of subsequent geomagnetic storms on satellite tracking and ephemeris computation. Author

**N91-17085*#** McDonnell-Douglas Space Systems Co., Houston, TX. Engineering Services.
**SPACE STATION FREEDOM ALTITUDE STRATEGY**
Brian M. McDonald and Scott B. Teplitz *In* NASA, Goddard Space Flight Center, Flight Mechanics/Estimation Theory Symposium, 1990 Dec. 1990 p 197-211 (For primary document see N91-17073 09-13)
Avail: NTIS HC/MF A23 CSCL 22A

The Space Station Freedom (SSF) altitude strategy provides guidelines and assumptions to determine an altitude profile for Freedom. The process for determining an altitude profile incorporates several factors such as where the Space Shuttle will rendezvous with the SSF, when reboosts must occur, and what atmospheric conditions exist causing decay. The altitude strategy has an influence on all areas of SSF development and mission planning. The altitude strategy directly affects the micro-gravity environment for experiments, propulsion and control system sizing, and Space Shuttle delivery manifests. Indirectly the altitude strategy influences almost every system and operation within the Space Station Program. Evolution of the SSF altitude strategy has been a very dynamic process over the past few years. Each altitude strategy in turn has emphasized a different consideration. Examples include a constant Space Shuttle rendezvous altitude for mission planning simplicity, or constant micro-gravity levels with its inherent emphasis on payloads, or lifetime altitudes to provide a safety buffer to loss of control conditions. Currently a new altitude strategy is in development. This altitude strategy will emphasize Space Shuttle delivery optimization. Since propellant is counted against Space Shuttle payload-to-orbit capacity, lowering the rendezvous altitude will not always increase the net payload-to-orbit, since more propellant would be required for reboost. This altitude strategy will also consider altitude biases to account for Space Shuttle launch slips and an unexpected worsening of atmospheric conditions. Safety concerns will define a lower operational altitude limit, while radiation levels will define upper altitude constraints. The evolution of past and current SSF altitude strategies and the development of a new altitude strategy which focuses on operational issues as opposed to design are discussed. Author

**N91-17086*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
**THE ACCURACY OF DYNAMIC ATTITUDE PROPAGATION**
E. Harvie, D. Chu (Computer Sciences Corp., Silver Spring, MD.), and M. Woodard *In its* Flight Mechanics/Estimation Theory

Symposium, 1990 Dec. 1990 p 213-231 (For primary document see N91-17073 09-13)
(Contract NAS5-31500)
Avail: NTIS HC/MF A23 CSCL 22A

Propagating attitude by integrating Euler's equation for rigid body motion has long been suggested for the Earth Radiation Budget Satellite (ERBS) but until now has not been implemented. Because of limited Sun visibility, propagation is necessary for yaw determination. With the deterioration of the gyros, dynamic propagation has become more attractive. Angular rates are derived from integrating Euler's equation with a stepsize of 1 second, using torques computed from telemetered control system data. The environmental torque model was quite basic. It included gravity gradient and unshadowed aerodynamic torques. Knowledge of control torques is critical to the accuracy of dynamic modeling. Due to their coarseness and sparsity, control actuator telemetry were smoothed before integration. The dynamic model was incorporated into existing ERBS attitude determination software. Modeled rates were then used for attitude propagation in the standard ERBS fine-attitude algorithm. In spite of the simplicity of the approach, the dynamically propagated attitude matched the attitude propagated with good gyros well for roll and yaw but diverged up to 3 degrees for pitch because of the very low resolution in pitch momentum wheel telemetry. When control anomalies significantly perturb the nominal attitude, the effect of telemetry granularity is reduced and the dynamically propagated attitudes are accurate on all three axes. Author

**N91-17087*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
**COMPARISON AND TESTING OF EXTENDED KALMAN FILTERS FOR ATTITUDE ESTIMATION OF THE EARTH RADIATION BUDGET SATELLITE**
Julie Deutschmann, Itzhack Y. Bar-Itzhack, and Mohammad Rokni (Computer Sciences Corp., Lanham, MD.) *In its* Flight Mechanics/Estimation Theory Symposium, 1990 Dec. 1990 p 233-253 (For primary document see N91-17073 09-13)
Avail: NTIS HC/MF A23 CSCL 22A

The testing and comparison of two Extended Kalman Filters (EKFs) developed for the Earth Radiation Budget Satellite (ERBS) is described. One EKF updates the attitude quaternion using a four component additive error quaternion. This technique is compared to that of a second EKF, which uses a multiplicative error quaternion. A brief development of the multiplicative algorithm is included. The mathematical development of the additive EKF was presented in the 1989 Flight Mechanics/Estimation Theory Symposium along with some preliminary testing results using real spacecraft data. A summary of the additive EKF algorithm is included. The convergence properties, singularity problems, and normalization techniques of the two filters are addressed. Both filters are also compared to those from the ERBS operational ground support software, which uses a batch differential correction algorithm to estimate attitude and gyro biases. Sensitivity studies are performed on the estimation of sensor calibration states. The potential application of the EKF for real time and non-real time ground attitude determination and sensor calibration for future missions such as the Gamma Ray Observatory (GRO) and the Small Explorer Mission (SMEX) is also presented. Author

**N91-17088*#** Hughes Aircraft Co., Aurora, CO.
**ATTITUDE DETERMINATION AND CALIBRATION USING A RECURSIVE MAXIMUM LIKELIHOOD-BASED ADAPTIVE KALMAN FILTER**
D. A. Kelly, A. Fermelia, and G. K. F. Lee (North Carolina State Univ., Raleigh.) *In* NASA, Goddard Space Flight Center, Flight Mechanics/Estimation Theory Symposium, 1990 Dec. 1990 p 255-274 (For primary document see N91-17073 09-13)
Avail: NTIS HC/MF A23 CSCL 22A

An adaptive Kalman filter design that utilizes recursive maximum likelihood parameter identification is discussed. At the center of this design is the Kalman filter itself, which has the responsibility for attitude determination. At the same time, the identification algorithm is continually identifying the system parameters. The approach is applicable to nonlinear, as well as linear systems. This adaptive Kalman filter design has much potential for real time implementation, especially considering the fast clock speeds, cache memory and internal RAM available today. The recursive maximum likelihood algorithm is discussed in detail, with special attention directed towards its unique matrix formulation. The procedure for using the algorithm is described along with comments on how this algorithm interacts with the Kalman filter. Author

**N91-17089*#** State Univ. of New York, Buffalo. Dept. of Mechanical and Aerospace Engineering.
**AN EXPERIMENTAL STUDY OF NONLINEAR DYNAMIC SYSTEM IDENTIFICATION**
Greselda I. Stry and D. Joseph Mook *In* NASA, Goddard Space Flight Center, Flight Mechanics/Estimation Theory Symposium, 1990 Dec. 1990 p 275-290 (For primary document see N91-17073 09-13)
Avail: NTIS HC/MF A23 CSCL 22A

A technique for robust identification of nonlinear dynamic systems is developed and illustrated using both simulations and analog experiments. The technique is based on the Minimum Model Error optimal estimation approach. A detailed literature review is included in which fundamental differences between the current approach and previous work is described. The most significant feature of the current work is the ability to identify nonlinear dynamic systems without prior assumptions regarding the form of the nonlinearities, in constrast to existing nonlinear identification approaches which usually require detailed assumptions of the nonlinearities. The example illustrations indicate that the method is robust with respect to prior ignorance of the model, and with respect to measurement noise, measurement frequency, and measurement record length. Author

**N91-17090*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**DOWNDATING A TIME-VARYING SQUARE ROOT INFORMATION FILTER**
Ronald J. Muellerschoen *In* NASA, Goddard Space Flight Center, Flight Mechanics/Estimation Theory Symposium, 1990 Dec. 1990 p 291-298 (For primary document see N91-17073 09-13)
Avail: NTIS HC/MF A23 CSCL 22A

A new method to efficiently downdate an estimate and covariance generated by a discrete time Square Root Information Filter (SRIF) is presented. The method combines the QR factor downdating algorithm of Gill and the decentralized SRIF algorithm of Bierman. Efficient removal of either measurements or a priori information is possible without loss of numerical integrity. Moreover, the method includes features for detecting potential numerical degradation. Performance on a 300 parameter system with 5800 data points shows that the method can be used in real time and hence is a promising tool for interactive data analysis. Additionally, updating a time-varying SRIF filter with either additional measurements or a priori information proceeds analogously.
Author

**N91-17091*#** Satellite Control Squadron (2nd), Falcon AFB, CO.
**THE NAVSTAR GPS MASTER CONTROL STATION'S KALMAN FILTER EXPERIENCE**
Michael P. Scardera *In* NASA, Goddard Space Flight Center, Flight Mechanics/Estimation Theory Symposium, 1990 Dec. 1990 p 299-319 (For primary document see N91-17073 09-13)
Avail: NTIS HC/MF A23 CSCL 22A

The Navstar Global Positioning System (GPS) is a highly accurate space based navigation system providing all weather, 24 hour a day service to both military and civilian users. The system provides a Gaussian position solution with four satellites, each providing its ephemeris and clock offset with respect to GPS time. The GPS Master Clock Station (MCS) is charged with tracking each Navstar spacecraft and precisely defining the ephemeris and clock parameters for upload into the vehicle's navigation message.

Briefly described here are the Navstar system and the Kalman filter estimation process used by MCS to determine, predict, and ensure quality control for each of the satellite's ephemeris and clock states. Routine performance is shown. Kalman filter reaction and response is discussed for anomalous clock behavior and trajectory perturbations. Particular attention is given to MCS efforts to improve orbital adjust modeling. The satellite out of service time due to orbital maneuvering has been reduced in the past year from four days to under twelve hours. The planning, reference trajectory model, and Kalman filter management improvements are explained. Author

**N91-17092*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
**GAMMA RAY OBSERVATORY (GRO) OBC ATTITUDE ERROR ANALYSIS**
R. R. Harman *In its* Flight Mechanics/Estimation Theory Symposium, 1990 Dec. 1990 p 321-340 (For primary document see N91-17073 09-13)
Avail: NTIS HC/MF A23 CSCL 22A

This analysis involves an in-depth look into the onboard computer (OBC) attitude determination algorithm. A review of TRW error analysis and necessary ground simulations to understand the onboard attitude determination process are performed. In addition, a plan is generated for the in-flight calibration and validation of OBC computed attitudes. Pre-mission expected accuracies are summarized and sensitivity of onboard algorithms to sensor anomalies and filter tuning parameters are addressed. Author

**N91-17093*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
**TWO AXIS POINTING SYSTEM (TAPS) ATTITUDE ACQUISITION, DETERMINATION, AND CONTROL**
John D. Azzolini and David E. McGlew *In its* Flight Mechanics/Estimation Theory Symposium, 1990 Dec. 1990 p 341-358 (For primary document see N91-17073 09-13)
Avail: NTIS HC/MF A23 CSCL 22A

The Two Axis Pointing System (TAPS) is a 2 axis gimbal system designed to provide fine pointing of Space Transportation System (STS) borne instruments. It features center-of-mass instrument mounting and will accommodate instruments of up to 1134 kg (2500 pounds) which fit within a 1.0 by 1.0 by 4.2 meter (40 by 40 by 166 inch) envelope. The TAPS system is controlled by a microcomputer based Control Electronics Assembly (CEA), a Power Distribution Unit (PDU), and a Servo Control Unit (SCU). A DRIRU-II inertial reference unit is used to provide incremental angles for attitude propagation. A Ball Brothers STRAP star tracker is used for attitude acquisition and update. The theory of the TAPS attitude determination and error computation for the Broad Band X-ray Telescope (BBXRT) are described. The attitude acquisition is based upon a 2 star geometric solution. The acquisition theory and quaternion algebra are presented. The attitude control combines classical position, integral and derivative (PID) control with techniques to compensate for coulomb friction (bias torque) and the cable harness crossing the gimbals (spring torque). Also presented is a technique for an adaptive bias torque compensation which adjusts to an ever changing frictional torque environment. The control stability margins are detailed, with the predicted pointing performance, based upon simulation studies. The TAPS user interface, which provides high level operations commands to facilitate science observations, is outlined. Author

**N91-17094*#** Computer Sciences Corp., Silver Spring, MD.
**A METHOD OF DETERMINING ATTITUDE FROM MAGNETOMETER DATA ONLY**
G. A. Natanson, S. F. McLaughlin, and R. C. Nicklas *In* NASA, Goddard Space Flight Center, Flight Mechanics/Estimation Theory Symposium, 1990 Dec. 1990 p 359-378 (For primary document see N91-17073 09-13)
(Contract NAS5-31500)
Avail: NTIS HC/MF A23 CSCL 22A

Presented here is a new algorithm to determine attitude using only magnetometer data under the following conditions: (1) internal torques are known and (2) external torques are negligible. Torque-free rotation of a spacecraft in thruster firing acquisition phase and its magnetic despin in the B-dot mode give typical examples of such situations. A simple analytical formula has been derived in the limiting case of a spacecraft rotating with constant angular velocity. The formula has been tested using low-frequency telemetry data for the Earth Radiation Budget Satellite (ERBS) under normal conditions. Observed small oscillation of body-fixed components of the angular velocity vector near their mean values result in relatively minor errors of approximately 5 degrees. More significant errors come from processing digital magnetometer data. Higher resolution of digitized magnetometer measurements would significantly improve the accuracy of this deterministic scheme. Tests of the general version of the developed algorithm for a free-rotating spacecraft and for the B-dot mode are in progress. Author

**N91-17095*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
**ON-BOARD ATTITUDE DETERMINATION AND CONTROL ALGORITHMS FOR SAMPEX**
Thomas W. Flatley, Josephine K. Forden, Debra A. Henretty, E. Glenn Lightsey, and F. Landis Markley *In its* Flight Mechanics/Estimation Theory Symposium, 1990 Dec. 1990 p 379-398 (For primary document see N91-17073 09-13)
Avail: NTIS HC/MF A23 CSCL 22A

Algorithms for onboard attitude determination and control of the Solar, Anomalous, and Magnetospheric Particle Explorer (SAMPEX) were developed. The algorithms include spacecraft ephemeris and geomagnetic field models, attitude determination with 2 degree accuracy, control of pitch axis pointing to the sun and yaw axis pointing away from the Earth to achieve control of pitch axis within 5 degrees of sunline, momentum unloading, and nutation damping. The closed loop simulations were performed on a VAX 8830 using a prototype version of the on-board software. Author

**N91-17096*#** Rockwell International Corp., Downey, CA. Space Operations.
**ATTITUDE-DEPENDENT LAUNCH WINDOW ANALYSIS FOR THE HUBBLE SPACE TELESCOPE MISSION**
James A. Lenio *In* NASA, Goddard Space Flight Center, Flight Mechanics/Estimation Theory Symposium, 1990 Dec. 1990 p 399-415 (For primary document see N91-17073 09-13)
Avail: NTIS HC/MF A23 CSCL 22A

Launch window analysis for Space Shuttle missions determines the launch times which will ensure that all payload and Shuttle requirements for the mission are met. Attitude and pointing analysis determines Shuttle Orbiter attitudes that meet various communication, viewing, and thermal requirements for the Orbiter and its payloads. Historically, launch window analysis and attitude and pointing analysis for Shuttle missions have been done separately, without directly influencing each other. However, methods have been developed to consider simultaneously dependencies between launch window and attitude and pointing requirements if they arise. These methods were developed from the launch window analysis for STS-31, the Hubble Space Telescope (HST) deployment mission. To release the HST, the Orbiter attitude had to remain inertially fixed while pointing the HST at the Sun. The Orbiter release attitude and the HST release time were determined from the position of the Sun and varied with launch time and launch date. The launch window analysis for STS-31 centered on how to determine the range of launch times for a given launch date that would allow the Shuttle to release the HST and simultaneously satisfy communication, attitude, and lighting requirements for the deployment operations. Discussed here are how the HST deployment requirements determined the launch window and how the Orbiter release attitude affected the launch window. Author

**N91-17097*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
**CONTRIBUTION OF ZONAL HARMONICS TO GRAVITATIONAL MOMENT**
Carlos M. Roithmayr *In* NASA, Goddard Space Flight Center, Flight Mechanics/Estimation Theory Symposium, 1990 Dec. 1990 p 417-429 (For primary document see N91-17073 09-13)
Avail: NTIS HC/MF A23 CSCL 22A

A celestial body produces a gravitational moment about the mass center of a small orbiting body, which affects the orientation of the smaller body. Each zonal harmonic in the gravitational potential of a celestial body is shown to make a contribution to the gravitational moment which can be expressed in a recursive vector-dyadic form. A formal derivation is presented, followed by an example in which the result is employed in obtaining the contribution of the zonal harmonic of 2nd degree. The contribution of the zonal harmonic of 3rd degree is also reported. Author

**N91-17098*#** Fairchild Space Co., Germantown, MD. Space Systems Div.
**A TECHNIQUE FOR OPTIMAL TEMPERATURE ESTIMATION FOR MODELING SUNRISE/SUNSET THERMAL SNAP DISTURBANCE TORQUE**
D. F. Zimbelman, C. J. Dennehy, R. V. Welch, and G. H. Born (Colorado Univ., Boulder.) *In* NASA, Goddard Space Flight Center, Flight Mechanics/Estimation Theory Symposium, 1990 Dec. 1990 p 431-446 (For primary document see N91-17073 09-13)
Avail: NTIS HC/MF A23 CSCL 22A

A predictive temperature estimation technique which can be used to drive a model of the Sunrise/Sunset thermal 'snap' disturbance torque experienced by low Earth orbiting spacecraft is described. The twice per orbit impulsive disturbance torque is attributed to vehicle passage in and out of the Earth's shadow cone (umbra), during which large flexible appendages undergo rapidly changing thermal conditions. Flexible members, in particular solar arrays, experience rapid cooling during umbra entrance (Sunset) and rapid heating during exit (Sunrise). The thermal 'snap' phenomena has been observed during normal on-orbit operations of both the LANDSAT-4 satellite and the Communications Technology Satellite (CTS). Thermal 'snap' has also been predicted to be a dominant source of error for the TOPEX satellite. The fundamental equations used to model the Sunrise/Sunset thermal 'snap' disturbance torque for a typical solar array like structure will be described. For this derivation the array is assumed to be a thin, cantilevered beam. The time varying thermal gradient is shown to be the driving force behind predicting the thermal 'snap' disturbance torque and therefore motivates the need for accurate estimates of temperature. The development of a technique to optimally estimate appendage surface temperature is highlighted. The objective analysis method used is structured on the Gauss-Markov Theorem and provides an optimal temperature estimate at a prescribed location given data from a distributed thermal sensor network. The optimally estimated surface temperatures could then be used to compute the thermal gradient across the body. The estimation technique is demonstrated using a typical satellite solar array. Author

**N91-17099*#** Northrop Corp., Anaheim, CA.
**THE GENERALIZED TSIOLKOVSKY EQUATION**
V. N. Dvornychenko *In* NASA, Goddard Space Flight Center, Flight Mechanics/Estimation Theory Symposium, 1990 Dec. 1990 p 449-457 (For primary document see N91-17073 09-13)
Avail: NTIS HC/MF A23 CSCL 22A

The performance of a rocket, say a chemical rocket, can be greatly improved by dynamically transferring energy from one part of the propellant to another. Although with present technology the achievable degree of energy concentration is low, payload increases on the order of 20 percent are theoretically possible. With unlimited energy redistribution increases of a factor of two are possible. Author

**N91-17100*#** Computer Sciences Corp., Silver Spring, MD.
**CALCULATION OF DOUBLE-LUNAR SWINGBY TRAJECTORIES: PART 2: NUMERICAL SOLUTIONS IN THE RESTRICTED PROBLEM OF THREE BODIES**
S. Stalos *In* NASA, Goddard Space Flight Center, Flight Mechanics/Estimation Theory Symposium, 1990 Dec. 1990 p 459-470 (For primary document see N91-17073 09-13)
(Contract NAS5-31500)
Avail: NTIS HC/MF A23 CSCL 22A

The double-lunar swingby trajectory is a method for maintaining alignment of an Earth satellite's line of apsides with the Sun-Earth line. From a Keplerian point of view, successive close encounters with the Moon cause discrete, instantaneous changes in the satellite's eccentricity and semimajor axis. Numerical solutions to the planar, restricted problem of three bodies as double-lunar swingby trajectories are identified. The method of solution is described and the results compared to the Keplerian formulation. Author

**N91-17101*#** McDonnell-Douglas Space Systems Co., Huntington Beach, CA.
**OPTIMAL AEROASSISTED ORBITAL TRANSFER WITH PLANE CHANGE USING COLLOCATION AND NONLINEAR PROGRAMMING**
Yun. Y. Shi, R. L. Nelson, and D. H. Young *In* NASA, Goddard Space Flight Center, Flight Mechanics/Estimation Theory Symposium, 1990 Dec. 1990 p 471-490 (For primary document see N91-17073 09-13)
Avail: NTIS HC/MF A23 CSCL 22A

The fuel optimal control problem arising in the non-planar orbital transfer employing aeroassisted technology is addressed. The mission involves the transfer from high energy orbit (HEO) to low energy orbit (LEO) with orbital plane change. The basic strategy here is to employ a combination of propulsive maneuvers in space and aerodynamic maneuvers in the atmosphere. The basic sequence of events for the aeroassisted HEO to LEO transfer consists of three phases. In the first phase, the orbital transfer begins with a deorbit impulse at HEO which injects the vehicle into an elliptic transfer orbit with perigee inside the atmosphere. In the second phase, the vehicle is optimally controlled by lift and bank angle modulations to perform the desired orbital plane change and to satisfy heating constraints. Because of the energy loss during the turn, an impulse is required to initiate the third phase to boost the vehicle back to the desired LEO orbital altitude. The third impulse is then used to circularize the orbit at LEO. The problem is solved by a direct optimization technique which uses piecewise polynomial representation for the state and control variables and collocation to satisfy the differential equations. This technique converts the optimal control problem into a nonlinear programming problem which is solved numerically. Solutions were obtained for cases with and without heat constraints and for cases of different orbital inclination changes. The method appears to be more powerful and robust than other optimization methods. In addition, the method can handle complex dynamical constraints. Author

**N91-17102*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
**AEROBRAKING FOR CAPTURE INTO MARTIAN ORBIT**
William T. Suit, Mary C. Lee, Paul V. Tartbini, and Barbara S. Tomlinson *In* NASA, Goddard Space Flight Center, Flight Mechanics/Estimation Theory Symposium, 1990 Dec. 1990 p 491-510 (For primary document see N91-17073 09-13)
Avail: NTIS HC/MF A23 CSCL 22A

A summary is given of several studies into problems associated with aerobraking a manned vehicle into a Martian capture orbit. The problems investigated are the establishment of entry flight path angle windows that allow aerocapture; the determination of the sensitivity of the entry trajectory to initial flight path angle; the determination of the effect on aerocapture of the assumed Martian atmosphere model; and the determination of the effect of random atmosphere disturbances on adaptive guidance systems that may be used for aerocapture. As a result of investigating the above

problem areas, entry windows were established for three different vehicle configurations. Sensitivities to changes in initial flight path angle were also obtained for these three configurations. One configuration was chosen to determine the effect of Martian atmospheric model changes and random variations of density within a specific atmospheric model. Of particular interest was the effect of random density variations on adaptive guidance techniques. The effect of entry velocity on the size of the entry window was also examined. Author

**N91-17103*#** General Dynamics Corp., San Diego, CA. Trajectory and Performance Dept.
**UPPER STAGE IN-FLIGHT RETARGETING TO ENHANCE GEOSYNCHRONOUS SATELLITE OPERATIONS**
Otto W. K. Lee *In* NASA, Goddard Space Flight Center, Flight Mechanics/Estimation Theory Symposium, 1990 Dec. 1990 p 511-520 (For primary document see N91-17073 09-13)
Avail: NTIS HC/MF A23 CSCL 22A

Real time utilization of propellant reserves that are not needed is available with the implementation of the in-flight retargeting capability for the Centaur Upper Stage. Application to a performance critical, geosynchronous mission is discussed. The operational duration of the satellite may be increased by selectively choosing the appropriate final orbit injection conditions. During ascent Centaur evaluates the amount of propellant excess available and adjusts the final orbit target to consume the excess. Typical satellite mission requirements are introduced to illustrate the mission analysis process to determine the pre-flight nominal target and the in-flight retarget function. Author

**N91-17104*#** Computer Sciences Corp., Silver Spring, MD.
**CONSTANT PROPELLANT USE RENDEZVOUS SCENARIO ACROSS A LAUNCH WINDOW FOR REFUELING MISSIONS**
M. E. Hametz and R. Whittier *In* NASA, Goddard Space Flight Center, Flight Mechanics/Estimation Theory Symposium, 1990 Dec. 1990 p 521-538 (For primary document see N91-17073 09-13)
(Contract NAS5-31500)
Avail: NTIS HC/MF A23 CSCL 22A

Active rendezvous of an unmanned spacecraft with the Space Transportation System (STS) Shuttle for refueling missions is investigated. The operational constraints facing both the maneuvering spacecraft and the Shuttle during a rendezvous sequence are presented. For example, the user spacecraft must arrive in the generic Shuttle control box at a specified time after Shuttle launch. In addition, the spacecraft must be able to initiate the transfer sequence from any point in its orbit. The standard four-burn rendezvous sequence, consisting of two Hohmann transfers and an intermediate phasing orbit, is presented as a low-energy solution for rendezvous and retrieval missions. However, for refueling missions, the Shuttle must completely refuel the spacecraft and return to Earth with no excess fuel. This additional constraint is not satisfied by the standard four-burn sequence. Therefore, a variation of the four-burn rendezvous, the constant delta-V scenario, was developed to satisfy the added requirement. Author

**N91-17105*#** Eastern Connecticut State Coll., Willimantic. Dept. of Mathematics and Computer Science.
**OPTIMAL TRAJECTORIES BASED ON LINEAR EQUATIONS**
Thomas E. Carter *In* NASA, Goddard Space Flight Center, Flight Mechanics/Estimation Theory Symposium, 1990 Dec. 1990 p 539-556 (For primary document see N91-17073 09-13)
Avail: NTIS HC/MF A23 CSCL 22A

The Principal results of a recent theory of fuel optimal space trajectories for linear differential equations are presented. Both impulsive and bounded-thrust problems are treated. A new form of the Lawden Primer vector is found that is identical for both problems. For this reason, starting iteratives from the solution of the impulsive problem are highly effective in the solution of the two-point boundary-value problem associated with bounded thrust. These results were applied to the problem of fuel optimal maneuvers of a spacecraft near a satellite in circular orbit using the Clohessy-Wiltshire equations. For this case two-point boundary-value problems were solved using a microcomputer, and optimal trajectory shapes displayed. The results of this theory can also be applied if the satellite is in an arbitrary Keplerian orbit through the use of the Tschauner-Hempel equations. A new form of the solution of these equations has been found that is identical for elliptical, parabolic, and hyperbolic orbits except in the way that a certain integral is evaluated. For elliptical orbits this integral is evaluated through the use of the eccentric anomaly. An analogous evaluation is performed for hyperbolic orbits. Author

# 14 GROUND SUPPORT SYSTEMS AND FACILITIES (SPACE)

Includes launch complexes, research and production facilities; ground support equipment, e.g., mobile transporters; and simulators.

For related information see also *09 Research and Support Facilities (Air).*

**N91-17106*#** Houston Univ., Clear Lake, TX. Research Inst. for Computing and Information Systems.
**RESEARCH AND DEVELOPMENT FOR ONBOARD NAVIGATION (ONAV) GROUND BASED EXPERT/TRAINER SYSTEM: ONAV ENTRY KNOWLEDGE REQUIREMENTS SPECIFICATION UPDATE**
Daniel C. Bochsler (LinCom Corp., Houston, TX.) 1 Mar. 1988 128 p
(Contract NCC9-16)
(NASA-CR-187241; NAS 1.26:187241) Avail: NTIS HC/MF A07 CSCL 14B

A revised version of expert knowledge for the onboard navigation (ONAV) entry system is given. Included is some brief background information together with information describing the knowledge that the system does contain. Author

**N91-17107#** Oak Ridge National Lab., TN.
**QUICKGUN: AN ALGORITHM FOR ESTIMATING THE PERFORMANCE OF TWO-STAGE LIGHT GAS GUNS**
S. L. Milora, S. K. Combs, M. J. Gouge, and R. W. Kincaid (North Carolina State Univ., Raleigh.) Sep. 1990 21 p
(Contract DE-AC05-84OR-21400)
(DE91-004973; ORNL/TM-11561) Avail: NTIS HC/MF A03

An approximate method is described for solving the equation of motion of a projectile accelerated by a two-stage light gas gun that uses high-pressure (less than 100 bar) gas from a storage reservoir to drive a piston to moderate speed (less than 400 m/s) for the purpose of compressing the low molecular weight propellant gas (hydrogen or helium) to high pressure (1000 to 10,000 bar) and temperature (1000 to 10,000 K). Zero-dimensional, adiabatic (isentropic) processes are used to describe the time dependence of the ideal gas thermodynamic properties of the storage reservoir and the first and second stages of the system. A one-dimensional model based on an approximate method of characteristics, or wave diagram analysis, for flow with friction (nonisentropic) is used to describe the nonsteady compressible flow processes in the launch tube. Linear approximations are used for the characteristic and fluid particle trajectories by averaging the values of the flow parameters at the breech and at the base of the projectile. An assumed functional form for the Mach number at the breech provides the necessary boundary condition. Results of the calculation are compared with data obtained from two-stage light gas gun experiments at Oak Ridge National Laboratory for solid deuterium and nylon projectiles with masses ranging from 10 to 35 mg and for projectile speeds between 1.6 and 4.5 km/s. The predicted and measured velocities generally agree to within 15 percent. DOE

**N91-17108** Minnesota Univ., Minneapolis.
**FUNDAMENTAL STUDY OF CLEAN ROOMS Ph.D. Thesis**

Seyed Mohammad Reza Sadjadi 1990 265 p
Avail: Univ. Microfilms Order No. DA9029706

Several critical issues affecting the operation of new generation cleanrooms are studied. Methods are suggested for predicting major sources of contamination in cleanrooms. Finally, a compute code is developed to predict contamination levels in a cleanroom. This code can be used as a tool in cleanroom design. Undetected small leaks in high efficiency particulate air (HEPA) or ultra low penetration air (ULPA) filters is a very important contamination source. Behavior and characteristics of pin-hole leaks are studied theoretically and experimentally. Instruments and necessary procedures are developed for detecting leaks as small as 2 microns in diameter. In the so-called vertical laminar flow (VLF) cleanroom, it is desired that the air flow be unidirectional, and uniform across the entire ceiling grid. The effect of plenum geometry on air flow uniformity in cleanrooms is studied experimentally and in theory. A new realistic numerical approach to the problem of flow distribution in cleanrooms is developed. Ambient aerosol penetrating through the filtration system of the cleanroom is a major source of particles smaller than 0.2 microns inside cleanrooms. A method is suggested for predicting ambient aerosol concentrations theoretically. A representative sample of typical particle generation rate, and distribution for particles larger than 0.01 microns, by people inside cleanrooms is collected. Finally, a computer program is developed that can predict the performance of a cleanroom as a function of several different variables including: ambient aerosol, HEPA and ULPA filters, pre-filters, leak flow rates, dimensions of cleanroom, air recirculation rate, total air flow rates, and contamination sources originating inside cleanrooms.
Dissert. Abstr.

**N91-17109#** Range Commanders Council, White Sands Missile Range, NM. Timing Committee.
**EVENT COUNT STATUS CODE FORMATS**
Sep. 1990 37 p
(AD-A229009; RCC-209-90) Avail: NTIS HC/MF A03 CSCL 12/5

Interrange and intrarange participation in launch, tracking, and recovery missions makes it mandatory to transmit count status information for visual display as well as for controlling event timers or sequencers. This standard defines the characteristics of four visual count status code formats. Each permissible code format is assigned a numerical designator, so users can define the particular code format being used. This standard reflects the state of the art and is not intended to constrain research and development in the area. This standard will be revised as required. This standard describes a family of four serial event count status (ECS) codes with formats containing coded expressions or words (and subwords) within a 1 second time frame. The basic intended use of these codes is to provide visual count status information; however, the codes can be used for computer input to correlate data with time or with count status. Also, if desired, the codes can be used to not only drive visual displays but to turn on equipment such as cameras and recorders. The application of these codes is at the discretion of the user range or facility. These codes can be software and hardware generated and controlled depending on the user requirement and application. GRA

**N91-17110#** Ballistic Research Labs., Aberdeen Proving Ground, MD.
**A TECHNICAL ASSESSMENT OF ELECTROMAGNETIC PROPULSION FOR SMALL CALIBER WEAPONS APPLICATIONS Final Report, Oct. 1987 - Oct. 1988**
Keith A. Jamison Nov. 1990 88 p
(AD-A229233; BRL-TR-3170) Avail: NTIS HC/MF A05 CSCL 20/3

An assessment of the future potential of electromagnetic propulsion for small caliber weapons has been performed to consider possible benefits, systems configurations, research and development needs, and mission requirements. The assessment consists of a panel evaluation of an existing electromagnetic launcher EML program and comparisons of envisioned point designs for small caliber weapons systems. The general conclusions are that the present research effort is well-founded and that EM propulsion has a great deal of potential for a vehicle mounted, crew-served weapon. Although the potential improvements are significant, some risk in maturing the technology to a fielded weapon is accrued from the number and complexity of components in the EML system. GRA

# 15 LAUNCH VEHICLES AND SPACE VEHICLES

Includes boosters; operating problems of launch/space vehicle systems; and reusable vehicles.

For related information see also *20 Spacecraft Propulsion and Power.*

No abstracts in this category.

# 16 SPACE TRANSPORTATION

Includes passenger and cargo space transportation, e.g., shuttle operations; and space rescue techniques.

For related information see also *03 Air Transportation and Safety* and *18 Spacecraft Design, Testing and Performance.* For space suits see *54 Man/System Technology and Life Support.*

**N91-17111** Alabama Univ., Huntsville.
**A TRANSIENT RESPONSE ANALYSIS OF THE SPACE SHUTTLE VEHICLE DURING LIFTOFF Ph.D. Thesis**
Joseph Anthony Brunty 1990 128 p
Avail: Univ. Microfilms Order No. DA9032144

A proposed transient response method is formulated for the liftoff analysis of the Space Shuttle vehicle. The proposed method uses a power series approximation with unknown coefficients for the interface forces between the Space Shuttle and Mobile Launch Platform (MLP). This allows the equations of motion of the two structures to be solved separately with unknown coefficients at the end of each time step. The unknown coefficients are obtained by enforcing the interface compatibility conditions between the two structures. Once the unknown coefficients are determined the total response is computed for that time step. The method is validated by a numerical example of a cantilevered beam and by the liftoff analysis of the Space Shuttle vehicle. The proposed method is compared to an iterative transient response analysis method used by Martin Marietta for their Space Shuttle liftoff analysis. It is shown that the proposed method uses less computer time than the iterative method and does not require as small a time step for integration. The Space Shuttle vehicle model is reduced using two different types of component mode synthesis (CMS) methods, the Lanczos CMS method and the Craig and Bampton CMS method. By varying the cutoff frequency in the Craig and Bampton method it was shown that the Space Shuttle interface loads can be computed with reasonable accuracy. Both the Lanczos CMS method and Craig and Bampton CMS method give similar results. A substantial amount of computer time is saved using the Lanczos CMS method over that of the Craig and Bampton method. However, when trying to compute a large number of Lanczos vectors, input/output computer time increased and increased the overall computer time. The application of several liftoff release mechanisms that can be adapted to the proposed method are discussed. Dissert. Abstr.

**N91-17112*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
**THE AEROSPACE PLANE DESIGN CHALLENGE: CREDIBLE COMPUTATIONAL FLUID DYNAMICS RESULTS**
Unmeel B. Mehta Dec. 1990 27 p Presented at the 2nd AIAA International Aerospace Planes Conference, Orlanda, FL,

29-31 Oct. 1990
(NASA-TM-102887; A-91016; NAS 1.15:102887) Avail: NTIS HC/MF A03 CSCL 22B

Computational fluid dynamics (CFD) is necessary in the design processes of all current aerospace plane programs. Single-stage-to-orbit (STTO) aerospace planes with air-breathing supersonic combustion are going to be largely designed by means of CFD. The challenge of the aerospace plane design is to provide credible CFD results to work from, to assess the risk associated with the use of those results, and to certify CFD codes that produce credible results. To establish the credibility of CFD results used in design, the following topics are discussed: CFD validation vis-a-vis measurable fluid dynamics (MFD) validation; responsibility for credibility; credibility requirement; and a guide for establishing credibility. Quantification of CFD uncertainties helps to assess success risk and safety risks, and the development of CFD as a design tool requires code certification. This challenge is managed by designing the designers to use CFD effectively, by ensuring quality control, and by balancing the design process. For designing the designers, the following topics are discussed: how CFD design technology is developed; the reasons Japanese companies, by and large, produce goods of higher quality than the U.S. counterparts; teamwork as a new way of doing business; and how ideas, quality, and teaming can be brought together. Quality control for reducing the loss imparted to the society begins with the quality of the CFD results used in the design process, and balancing the design process means using a judicious balance of CFD and MFD. Author

**N91-17113*#** National Aeronautics and Space Administration. John F. Kennedy Space Center, Cocoa Beach, FL.
**DEBRIS/ICE/TPS ASSESSMENT AND PHOTOGRAPHIC ANALYSIS FOR SHUTTLE MISSION STS-38**
Scott A. Higginbotham and J. Bradley Davis Feb. 1991 180 p Original contains color illustrations
(NASA-TM-103815; NAS 1.15:103815) Avail: NTIS HC/MF A09; 64 functional color pages CSCL 22B

A debris/ice/TPS assessment and photographic analysis was conducted for the Space Shuttle Mission STS-38. Debris inspection of the flight elements and launch pad were performed before and after launch. Ice/frost conditions on the external tank were assessed by the use of computer programs, nomographs, and infrared scanner data during cryogenic loading of the vehicle followed by on-pad visual inspection. High speed photography was analyzed after launch to identify ice/debris sources and evaluate potential vehicle damage and/or in-flight anomalies. The debris/ice/TPS conditions and photographic analysis of Mission STS-38, and their overall effect on the Space Shuttle Program are documented. Author

**N91-17021*#** National Aeronautics and Space Administration, Washington, DC.
**NATIONAL SPACE TRANSPORTATION SYSTEM (NSTS) TECHNOLOGY NEEDS**
David L. Winterhalter and Kimberly K. Ulrich *In its* Space Transportation Avionics Technology Symposium. Volume 2: Conference Proceedings Aug. 1990 p 5-18 (For primary document see N91-17020 09-06)
Avail: NTIS HC/MF A99 CSCL 22B

**N91-17022*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
**NEXT MANNED TRANSPORTATION SYSTEM**
Harry Erwin *In* NASA, Washington, Space Transportation Avionics Technology Symposium. Volume 2: Conference Proceedings Aug. 1990 p 19-83 (For primary document see N91-17020 09-06)
Avail: NTIS HC/MF A99 CSCL 22B

**N91-17023*#** National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
**CARGO LAUNCH VEHICLES TO LOW EARTH ORBIT**
Robert E. Austin *In* NASA, Washington, Space Transportation Avionics Technology Symposium. Volume 2: Conference Proceedings Aug. 1990 p 85-129 (For primary document see N91-17020 09-06)
Avail: NTIS HC/MF A99 CSCL 22B

**N91-17029*#** National Aeronautics and Space Administration, Washington, DC.
**OPERATIONAL EFFICIENCY: AUTOMATIC ASCENT FLIGHT DESIGN**
*In its* Space Transportation Avionics Technology Symposium. Volume 2: Conference Proceedings Aug. 1990 p 277-304 (For primary document see N91-17020 09-06)
Avail: NTIS HC/MF A99 CSCL 22B

**N91-17030*#** National Aeronautics and Space Administration, Washington, DC.
**FLIGHT ELEMENTS SUBPANEL INTRODUCTION AND OVERVIEW**
Paul E. Sollock *In its* Space Transportation Avionics Technology Symposium. Volume 2: Conference Proceedings Aug. 1990 p 305-338 (For primary document see N91-17020 09-06)
Avail: NTIS HC/MF A99 CSCL 22B

**N91-17031*#** National Aeronautics and Space Administration, Washington, DC.
**PAYLOAD ACCOMMODATIONS: AVIONICS PAYLOAD SUPPORT ARCHITECTURE**
*In its* Space Transportation Avionics Technology Symposium. Volume 2: Conference Proceedings Aug. 1990 p 339-362 (For primary document see N91-17020 09-06)
Avail: NTIS HC/MF A99 CSCL 22B

**N91-17032*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
**SYSTEMS ENGINEERING AND INTEGRATION (SE AND I)**
Ed Chevers and Sam Haley *In* NASA, Washington, Space Transportation Avionics Technology Symposium. Volume 2: Conference Proceedings Aug. 1990 p 363-409 Prepared in cooperation with NASA, Marshall Space Flight Center, Huntsville, AL (For primary document see N91-17020 09-06)
Avail: NTIS HC/MF A99 CSCL 22B

**N91-17033*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
**OPERATIONAL EFFICIENCY: AUTOMATIC ASCENT FLIGHT DESIGN**
*In* NASA, Washington, Space Transportation Avionics Technology Symposium. Volume 2: Conference Proceedings Aug. 1990 p 415-422 (For primary document see N91-17020 09-06)
Avail: NTIS HC/MF A99 CSCL 22B

**N91-17034*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
**ADVANCED TRAINING SYSTEMS**
Robert T. Savely and R. Bowen Loftin (Houston Univ., TX.) *In* NASA, Washington, Space Transportation Avionics Technology Symposium. Volume 2: Conference Proceedings Aug. 1990 p 423-434 (For primary document see N91-17020 09-06)
Avail: NTIS HC/MF A99 CSCL 22B

**N91-17035*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
**ADVANCED AVIONICS CONCEPTS: AUTONOMOUS SPACECRAFT CONTROL**
*In* NASA, Washington, Space Transportation Avionics Technology Symposium. Volume 2: Conference Proceedings Aug. 1990 p 435-450 (For primary document see N91-17020 09-06)
Avail: NTIS HC/MF A99 CSCL 22B

**N91-17047*#** TRW Defense Systems Group, Houston, TX.
**PAYLOAD ACCOMMODATIONS. SATELLITE SERVICING SUPPORT**
Roscoe Lee *In* NASA, Washington, Space Transportation Avionics Technolody Symposium. Volume 2: Conference Proceedings Aug.

1990 p 647-656 (For primary document see N91-17020 09-06)
Avail: NTIS HC/MF A99 CSCL 22B

**N91-17053*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
**SE AND I SYSTEM TESTABILITY: THE KEY TO SPACE SYSTEM FDIR AND VERIFICATION TESTING**
Thomas Barry, Terrance Scheffer, Lynn R. Small, and Richard Monis (Harris Corp., Syosset, NY.) *In* NASA, Washington, Space Transportation Avionics Technology Symposium. Volume 2: Conference Proceedings Aug. 1990 p 701-706 (For primary document see N91-17020 09-06)
Avail: NTIS HC/MF A99 CSCL 22B

**N91-17056*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
**FLIGHT ELEMENTS SUBPANEL**
Claude R. Keckler *In* NASA, Washington, Space Transportation Avionics Technology Symposium. Volume 2: Conference Proceedings Aug. 1990 p 751-778 (For primary document see N91-17020 09-06)
Avail: NTIS HC/MF A99 CSCL 22B

**N91-17057*#** National Aeronautics and Space Administration, Washington, DC.
**PAYLOAD ACCOMMODATIONS**
*In its* Space Transportation Avionics Technology Symposium. Volume 2: Conference Proceedings Aug. 1990 p 779-789 (For primary document see N91-17020 09-06)
Avail: NTIS HC/MF A99 CSCL 22B

**N91-17058*#** National Aeronautics and Space Administration, Washington, DC.
**SYSTEMS ENGINEERING AND INTEGRATION (SE AND I)**
*In its* Space Transportation Avionics Technology Symposium. Volume 2: Conference Proceedings Aug. 1990 p 791-800 (For primary document see N91-17020 09-06)
Avail: NTIS HC/MF A99 CSCL 22B

# 17 SPACE COMM., SPACECRAFT COMM., COMMAND & TRACKING

Includes telemetry; space communications networks; astronavigation and guidance; and radio blackout.

For related information see also *04 Aircraft Communications and Navigation* and *32 Communications and Radar.*

**N91-17049*#** National Aeronautics and Space Administration, Washington, DC.
**ADVANCED TELEMETRY SYSTEMS FOR PAYLOADS. TECHNOLOGY NEEDS, OBJECTIVES AND ISSUES**
*In its* Space Transportation Avionics Technology Symposium. Volume 2: Conference Proceedings Aug. 1990 p 663-671 (For primary document see N91-17020 09-06)
Avail: NTIS HC/MF A99 CSCL 09F

# 18 SPACECRAFT DESIGN, TESTING AND PERFORMANCE

Includes satellites; space platforms; space stations; spacecraft systems and components such as thermal and environmental controls; and attitude controls.

For life support systems see *54 Man/System Technology and Life Support.* For related information see also *05 Aircraft Design, Testing and Performance, 39 Structural Mechanics,* and *16 Space Transportation.*

**N91-17114*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
**ON-ORBIT STRUCTURAL DYNAMIC PERFORMANCE OF A 15-METER MICROWAVE RADIOMETER ANTENNA**
Deborah M. Wahls, Jeffery T. Farmer, and David W. Sleight (Illinois Univ., Urbana.) Washington Dec. 1990 44 p
(NASA-TP-3041; L-16795; NAS 1.60:3041) Avail: NTIS HC/MF A03 CSCL 22B

The on-orbit structural dynamic performance of a microwave radiometer antenna for Earth science applications is addressed. The radiometer is one of the Earth-observing instruments aboard a proposed geostationary platform as part of the Mission to the Planet Earth. A sequential approach is presented for assessing the ability of an antenna structure to retain its geometric shape subject to a representative onboard disturbance. This approach includes establishing the structural requirements of the antenna, developing the structural and disturbance models, performing modal and forced response analyses, and evaluating the resulting distortions in terms of the antenna's ability to meet stringent structural performance requirements. Two antenna configurations kare discussed: free-flying and platform-mounted. These configurations are analyzed for a representative disturbance function which simulates rotation of the subreflector in order to perform a raster-type scan of the Earth disk. Results show that the scanning maneuver modeled would not induce antenna structural errors outside the specified limits. Author

**N91-17115*#** National Aeronautics and Space Administration, Washington, DC.
**THE GAMMA-RAY OBSERVATORY**
1990 39 p Original contains color illustrations
(NASA-NP-124; NAS 1.83:124) Avail: NTIS HC/MF A03; 32 functional color pages CSCL 22B

An overview is given of the Gamma Ray Observatory (GRO) mission. Detection of gamma rays and gamma ray sources, operations using the Space Shuttle, and instruments aboard the GRO, including the Burst and Transient Source Experiment (BATSE), the Oriented Scintillation Spectrometer Experiment (OSSE), the Imaging Compton Telescope (COMPTEL), and the Energetic Gamma Ray Experiment Telescope (EGRET) are among the topics surveyed. Author

**N91-17116*#** Federal Geodetic Control Committee, Rockville, MD. Instrument Subcommittee.
**TEST AND DEMONSTRATION OF GPS SATELLITE SURVEY SYSTEMS**
Larry D. Hothem Jun. 1990 67 p Sponsored by NASA, Washington, DC; Dept. of Agriculture; Dept. of Commerce; DOD; Army Corps of Engineers; HUD; Dept. of Interior; DOT; International Boundary Commission; Tennessee Valley Authority; and Bureau of Land Management
(NASA-CR-187685; NAS 1.26:187685; PB91-104505; FGCC-IS-90-1) Avail: NTIS HC/MF A04 CSCL 22B

Summary reports are compiled on testing and demonstration of the following satellite survey systems and associated processing software for them: TI4100 GPS Navigator, Trimble 4000S, ISTAC SERIES GPS Positioner Model 2002, Trimble 4000SX, WM101 GPS, Motorola Mini-Ranger Golden Eagle GPS Geodetic System, SERCEL Model NR52 GPS, Ashtech L-XII GPS, Norstar 1000 GPS, and Trimble 4000ST GPS Field Surveyor. Y.S.

**N91-17117*#** Federal Geodetic Control Committee, Rockville, MD. Instrument Subcommittee.
**TEST AND DEMONSTRATION OF THREE DUAL-FREQUENCY (L1/L2) GPS SATELLITE SURVEY SYSTEMS**
Larry D. Hothem Jun. 1990 36 p Sponsored by NASA, Washington, DC; Dept. of Agriculture; Dept. of Commerce; DOD; Army Corps of Engineers; HUD, Dept. of Interior; DOT; International Boundary Commission; Tennessee Valley Authority; and Bureau of Land Management
(NASA-CR-187727; NAS 1.26:187727; PB91-104513; FGCC-IS-90-2) Avail: NTIS HC/MF A03 CSCL 22B

Reports are presented on tests and demonstrations of the following GPS satellite survey systems and associated processing software: MINI-MAC(TM) Model 2816, 1816, and 1616; Trimble 4000SST; and Ashtech LD-XII. Y.S.

**N91-17118** Michigan Univ., Ann Arbor.
**PLANAR MOTION OF A TETHERED SATELLITE-PLATFORM SYSTEM IN A SLIGHTLY ELLIPTIC ORBIT Ph.D. Thesis**
Clare Mary Savaglio 1990 114 p
Avail: Univ. Microfilms Order No. DA9034505

A study of the in-plane dynamics of a tethered satellite-platform system in a slightly elliptic orbit is presented. The non-autonomous dynamic equations present a challenging problem for a stability analysis of the system. The system consists of a satellite attached to a platform with a tether. The tethered attachment point may be offset from the platform center of mass. The system equations of motion describe the platform pitch motion, tether libration, and tether length chance. It is shown that a periodic control to the second order of the eccentricity and periodic in the mean anomaly can be used to bound the effects of the forcing terms acting on the system to the order of eccentricity squared. The first order terms can be easily determined from the linearized periodic system equations. Dissert. Abstr.

**N91-17119** California Inst. of Tech., Pasadena.
**ROBUST CONTROL OF FLEXIBLE STRUCTURES: THEORY AND EXPERIMENTS Ph.D. Thesis**
Gary John Balas 1990 179 p
Avail: Univ. Microfilms Order No. DA9031431

Stringent requirements envisioned for the pointing and shape accuracy of future space missions necessitate advances in the control of large flexible structures. Due to their size and complexity, testing of these structures will lead to system models that are inaccurate for control purposes. Therefore, control design methods must be developed to account for model inaccuracies or uncertainties. Such methods should optimize the robustness and performance characteristics of control laws based on the accuracy of the design model. Incorporating the knowledge of the mismatch between the physical system and its mathematical models into the control design is emphasized. Control design models are developed to fit into the structured singular value framework that is used in the analysis and synthesis of control laws. To validate and verify theoretical developments, a flexible structure experiment is developed to investigate large flexible control problems in a laboratory environment. The Caltech experiment has a number of their attributes: closely spaced, lightly damped modes, collocated and noncollocated sensors, and actuators combined with numerous modes in the controller crossover region. The experimental structure is used to investigate several important issues related to control of flexible structures: (1) tradeoffs between robustness and performance associated with uncertainty modeling for flexible structures; (2) robust control of flexible modes in the controller crossover region; and (3) benefits and limitations of collocated versus noncollocated control design. A consistent trend in the results indicates that an accurate description of the flexible structure and model errors is required to synthesize high performance, robust control laws for flexible structures. Dissert. Abstr.

**N91-17120** Tennessee Univ., Knoxville.
**DESIGN AND DEVELOPMENT OF A SPACE STATION HAZARDOUS MATERIALS INFORMATION SYSTEM FOR ASSESSING CHEMICAL COMPATIBILITY Ph.D. Thesis**
Richard Thomas Congo 1990 293 p
Avail: Univ. Microfilms Order No. DA9030696

The need for and development of a modeling process which will perform chemical and material compatibility analyses for the Space Station Microgravity and Material Processing Facility (MMPF) is addressed. The modeling process includes development of a data base containing physical, chemical, toxicological, reactive, corrosive, and incompatibility properties for materials to be used in construction of the Space Station Freedom or in experiments to be conducted onboard. The underlying hypothesis of the modeling process is that by knowing the number of chemical incompatibilities, hazards, and corrosivities for any given facility or mission, one can modify or substitute chemicals for a facility or facility manifest to reduce the number of chemical incompatibilities, hazards, and corrosivities thus reducing the number of potential safety problems aboard the Space Station MMPF. The proposed process was developed into a computerized system with the aid of a relational data base and the development of application programs. An experiment was performed to validate the proposed model. This experiment consisted of utilizing the computerized system to identify the number of chemical incompatibilities, hazards and corrosivities for a given facility and a mission. The chemical requirements for the facility were modified utilizing substitute chemicals where appropriate, and the mission set was modified by replacing facilities with substitute facilities. The model was utilized to identify any reduction in the number of chemical incompatibilities, hazards, and corrosivities resulting from the substitutions. The results of the study and the experiments establish both the process and the hypothesis to be accurate.
Dissert. Abstr.

**N91-17121#** Office of Technology Assessment, Washington, DC.
**ORBITING DEBRIS: A SPACE ENVIRONMENTAL PROBLEM. BACKGROUND PAPER**
Oct. 1990 64 p
(PB91-114272; OTA-BP-ISC-72) Avail: NTIS HC/MF A04

Artificial debris, deposited in a multitude of orbits about the Earth as the result of the exploration and use of the space environment, poses a growing hazard to future space operations. Unless nations sharply reduce the amount of orbital debris they produce, future space activites could suffer loss of capability, loss of income, and even loss of life as a result of collisions between spacecraft and debris. This background paper discusses the sources of debris and how they can be greatly reduced. Author

**N91-17122#** Oesterreichisches Forschungszentrum Seibersdorf G.m.b.H., Vienna.
**EXAMINATION OF DEBRIS FROM SATELLITES WITH NUCLEAR REACTORS: A COMPARISON OF DIFFERENT METHODS [AUFSPUEREN VON BRUCHSTUECKEN VON SATELLITEN MIT KERNREAKTOREN: EIN VERGLEICH VERSCHIEDENER METHODEN]**
Konrad Mueck, Christian Schmitzer, Ernst Lovranich, Eberhart Henrich, Wolfgang Seiberl, and Gernot Oberlercher (Geologische Bundesanstalt, Vienna, Austria ) Jun. 1990 91 p In GERMAN; ENGLISH summary
(OEFZS-4541; ST-179/90; ETN-91-98535) Copyright Avail: NTIS HC/MF A05

The detection limits of different measuring techniques concerning the location of small, point like radiation sources, which occur as a consequence of a satellite crash with an on board nuclear reactor, were investigated. The minimum detectable activities of CO-60 at flight height of 100 m and a flight speed of 1000 km/hour amounted to approximately 2.9 GBq for dose equivalent GM detector systems, to about 1 GBq for HPGe detectors, to 0.17 GBq for 3 by 3 inch NaI detectors and to 0.05 GBq for extremely large NaI detectors. The deterioration of the detection limit upon changes in flight height, flight speed and the lateral derivation from direct overflight was investigated. From measurement data and derived detection limits, an optimal

measurement proposal adjusted to the available instruments is presented, which permits a quick covering surveillance of a possibly affected area. ESA

**N91-17123*#** Catholic Univ. of America, Washington, DC. Dept. of Electrical Engineering.
**ANALYSIS AND DESIGN OF A SIX-DEGREE-OF-FREEDOM STEWART PLATFORM-BASED ROBOTIC WRIST Semiannual Technical Report, 1 Aug. 1990 - 1 Jan. 1991**
Charles C. Nguyen, Sami Antrazi, and Zhen-Lei Zhou Feb. 1991 20 p
(Grant NAG5-780)
(NASA-CR-187660; NAS 1.26:187660) Avail: NTIS HC/MF A03 CSCL 22B

The kinematic analysis and implementation of a six degree of freedom robotic wrist which is mounted to a general open-kinetic chain manipulator to serve as a restbed for studying precision robotic assembly in space is discussed. The wrist design is based on the Stewart Platform mechanism and consists mainly of two platforms and six linear actuators driven by DC motors. Position feedback is achieved by linear displacement transducers mounted along the actuators and force feedback is obtained by a 6 degree of freedom force sensor mounted between the gripper and the payload platform. The robot wrist inverse kinematics which computes the required actuator lengths corresponding to Cartesian variables has a closed-form solution. The forward kinematics is solved iteratively using the Newton-Ralphson method which simultaneously provides a modified Jacobian Matrix which relates length velocities to Cartesian translational velocities and time rates of change of roll-pitch-yaw angles. Results of computer simulation conducted to evaluate the efficiency of the forward kinematics and Modified Jacobian Matrix are discussed. Author

**N91-17124#** Forward Unltd., Oxnard, CA.
**TWENTY-FIRST CENTURY SPACE PROPULSION STUDY Final Report, 30 Jul. 1987 - 30 Apr. 1990**
Robert L. Forward Oct. 1990 75 p
(Contract F04611-87-C-0029; AF Proj. 3058)
(AD-A229279; AL-TR-90-030) Avail: NTIS HC/MF A04 CSCL 21/3

The contract objective was to monitor the research at the forefront of physics and engineering to discover new space propulsion concepts. The major topics covered were antiproton annihilation propulsion, solar sails, space tethers, microspacecraft, and unconventional propulsion concepts. Nine papers were published on: (1) using light pressure to levitate a communication satellite poleward from its position on the equatorial geosynchronous orbit; (2) a polesitter spacecraft that uses light pressure to hover over the polar regions of the earth; (3) a complete analysis of all the forces on a non-ideal grey solar sail; (4) a new solar sail design with better performance than a standard solar sail; (5) a new tether transportation system called the cable catapult; (6) a thorough analysis of propulsion using negative matter; (7) a review of space warps; and (8,9) two reviews of advanced space propulsion. GRA

# 19 SPACECRAFT INSTRUMENTATION

For related information see also *06 Aircraft Instrumentation* and *35 Instrumentation and Photography.*

**N91-17075*#** Computer Sciences Corp., Lanham, MD.
**ATTITUDE SENSOR ALIGNMENT CALIBRATION FOR THE SOLAR MAXIMUM MISSION**
Daniel S. Pitone and Malcolm D. Shuster (Johns Hopkins Univ., Laurel, MD.) *In* NASA, Goddard Space Flight Center, Flight Mechanics/Estimation Theory Symposium, 1990 Dec. 1990 p 21-39 (For primary document see N91-17073 09-13)
Avail: NTIS HC/MF A23 CSCL 22B

**N91-17076*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
**INFLIGHT ESTIMATION OF GYRO NOISE**
O. H. Filla, T. Z. Willard, D. Chu (Computer Sciences Corp., Lanham, MD.), and Julie Deutschmann *In its* Flight Mechanics/Estimation Theory Symposium, 1990 Dec. 1990 p 41-58 (For primary document see N91-17073 09-13)
(Contract NAS5-31500)
Avail: NTIS HC/MF A23 CSCL 22B

**N91-17077*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
**FIXED-HEAD STAR TRACKER MAGNITUDE CALIBRATION ON THE SOLAR MAXIMUM MISSION**
Daniel S. Pitone, B. J. Twambly, A. H. Eudell, and D. A. Roberts *In its* Flight Mechanics/Estimation Theory Symposium, 1990 Dec. 1990 p 59-78 (For primary document see N91-17073 09-13)
Avail: NTIS HC/MF A23 CSCL 22B

# 20 SPACECRAFT PROPULSION AND POWER

Includes main propulsion systems and components, e.g., rocket engines; and spacecraft auxilliary power sources.

For related information see also *07 Aircraft Propulsion and Power, 28 Propellants and Fuels, 44 Energy Production and Conversion,* and *15 Launch Vehicles and Space Vehicles.*

**N91-17125#** Johns Hopkins Univ., Laurel, MD. Chemical Propulsion Information Agency.
**THE 26TH JANNAF COMBUSTION MEETING, VOLUME 2**
Dorothy L. Becker, ed. Oct. 1989 416 p Meeting held in Pasadena, CA, 23-27 Oct. 1989
(Contract N00039-89-C-0001)
(CPIA-PUBL-529-VOL-2) Avail: NTIS HC/MF A18

This second of five volumes is a collection of 35 unclassified papers from the conference. Specific subjects discussed include liquid and solid rocket performance and combustion instability. For individual titles, see N91-17126 through N91-17132.

**N91-17126*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
**EFFECTS OF H2O, CO2, AND N2 AIR CONTAMINANTS ON CRITICAL AIRSIDE STRAIN RATES FOR EXTINCTION OF HYDROGEN-AIR COUNTERFLOW DIFFUSION FLAMES**
G. L. Pellett, L. G. Wilson, G. B. Northam, and Rosemary Guerra (Rockwell International Corp., Canoga Park, CA.) *In* Johns Hopkins Univ., The 26th JANNAF Combustion Meeting, Volume 2 Oct. 1989 p 23-42 (For primary document see N91-17125 09-20)
Avail: NTIS HC/MF A18 CSCL 21H

Coaxial tubular opposed jet burners (OJB) were used to form dish shaped counterflow diffusion flames (CFDF), centered by opposing laminar jets of H2, N2 and both clean and contaminated air (O2/N2 mixtures) in an argon bath at 1 atm. Jet velocities for flame extinction and restoration limits are shown versus wide ranges of contaminant and O2 concentrations in the air jet, and also input H2 concentration. Blowoff, a sudden breaking of CFDF to a stable ring shape, occurs in highly stretched stagnation flows and is generally believed to measure kinetically limited flame reactivity. Restore, a sudden restoration of central flame, is a relatively new phenomenon which exhibits a H2 dependent hysteresis from Blowoff. For 25 percent O2 air mixtures, mole for mole replacement of 25 percent N2 contaminant by steam increased U(air) or flame strength at Blowoff by about 5 percent. This result is consistent with laminar burning velocity results from analogous substitution of steam for N2 in a premixed stoichiometric H2-O2-N2 (or steam) flame, shown by Koroll and Mulpuru to promote a 10 percent increase in experimental and calculated laminar burning velocity, due to enhanced third body efficiency of water in: H + O2 + M yields HO2 + M. When the OJB results were compared with Liu

and MacFarlane's experimental laminar burning velocity of premixed stoichiometric H2 + air + steam, a crossover occurred, i.e., steam enhanced OJB flame strength at extinction relative to laminar burning velocity. Author

**N91-17127*#** Aerojet TechSystems Co., Sacramento, CA.
**DEVELOPMENT OF A COMBUSTOR ANALYTICAL DESIGN METHODOLOGY FOR LIQUID ROCKET ENGINES** **c34**
Jerry L. Pieper and Jeff Muss *In* Johns Hopkins Univ., The 26th JANNAF Combustion Meeting, Volume 2 Oct. 1989 p 223-231 (For primary document see N91-17125 09-20)
(Contract NAS3-25556)
Avail: NTIS HC/MF A18 CSCL 20D

The development of a user friendly computerized methodology for the design and analysis of liquid propellant rocket engine combustion chambers is described. An overview of the methodology, consisting of a computer program containing an appropriate modular assembly of existing industry wide performance and combustion stability models, is presented. These models are linked with an interactive front end processor enabling the user to define the performance and stability traits of an existing design (point analysis) or to create the essential design features of a combustor to meet specific performance goals and combustion stability (point design). Plans for demonstration and verification of this methodology are also presented. These plans include the creation of combustor designs using the methodology, together with predictions of the performance and combustion stability for each design. A verification test program of 26 hot fire tests with up to four designs created using this methodology is described. This testing is planned using LOX/RP-1 propellants with a thrust level of approx. 220,000 N (50,000 lbf). Author

**N91-17128*#** CFD Research Corp., Huntsville, AL.
**ASSESSMENT OF NUMERICAL METHODS FOR THE SOLUTION OF FLUID DYNAMICS EQUATIONS FOR NONLINEAR RESONANCE SYSTEMS** **c34**
A. J. Przekwas and H. Q. Yang *In* Johns Hopkins Univ., The 26th JANNAF Combustion Meeting, Volume 2 Oct. 1989 p 233-242 Sponsored by NASA, Marshall Space Flight Center (For primary document see N91-17125 09-20)
Avail: NTIS HC/MF A18 CSCL 21H

The capability of accurate nonlinear flow analysis of resonance systems is essential in many problems, including combustion instability. Classical numerical schemes are either too diffusive or too dispersive especially for transient problems. In the last few years, significant progress has been made in the numerical methods for flows with shocks. The objective was to assess advanced shock capturing schemes on transient flows. Several numerical schemes were tested including TVD, MUSCL, ENO, FCT, and Riemann Solver Godunov type schemes. A systematic assessment was performed on scalar transport, Burgers' and gas dynamic problems. Several shock capturing schemes are compared on fast transient resonant pipe flow problems. A system of 1-D nonlinear hyperbolic gas dynamics equations is solved to predict propagation of finite amplitude waves, the wave steepening, formation, propagation, and reflection of shocks for several hundred wave cycles. It is shown that high accuracy schemes can be used for direct, exact nonlinear analysis of combustion instability problems, preserving high harmonic energy content for long periods of time. Author

**N91-17129*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**A ROCKET ENGINE DESIGN EXPERT SYSTEM**
Kenneth J. Davidian *In* Johns Hopkins Univ., The 26th JANNAF Combustion Meeting, Volume 2 Oct. 1989 p 293-300 (For primary document see N91-17125 09-20)
Avail: NTIS HC/MF A18 CSCL 20D

The overall structure and capabilities of an expert system designed to evaluate rocket engine performance are described. The expert system incorporates a JANNAF standard reference computer code to determine rocket engine performance and a state of the art finite element computer code to calculate the interactions between propellant injection, energy release in the combustion chamber, and regenerative cooling heat transfer. Rule-of-thumb heuristics were incorporated for the H2-O2 coaxial injector design, including a minimum gap size constraint on the total number of injector elements. One dimensional equilibrium chemistry was used in the energy release analysis of the combustion chamber. A 3-D conduction and/or 1-D advection analysis is used to predict heat transfer and coolant channel wall temperature distributions, in addition to coolant temperature and pressure drop. Inputting values to describe the geometry and state properties of the entire system is done directly from the computer keyboard. Graphical display of all output results from the computer code analyses is facilitated by menu selection of up to five dependent variables per plot. Author

**N91-17130*#** National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
**FURTHER IMPROVEMENTS TO NOZZLE BOUNDARY LAYER CALCULATIONS IN BLIMPJ** **c34**
S. C. Praharaj (Remtech, Inc., Huntsville, AL.) and Klaus W. Gross *In* Johns Hopkins Univ., The 26th JANNAF Combustion Meeting, Volume 2 Oct. 1989 p 311-325 (For primary document see N91-17125 09-20)
Avail: NTIS HC/MF A18 CSCL 20D

Further improvements made to advance the current Boundary Layer Integral Matrix Procedure - Version J (BLIMPJ) containing previously modeled simplified calculation methods by accounting for condensed phase, thick boundary layer and free stream turbulence effects are discussed. The condensed phase effects were included through species composition effect considered via input to the code and through particle damping effect considered via a turbulence model. The thrust loss calculation procedure for thick boundary layer effects was improved and the optimization of net thrust with respect to nozzle length was performed. The effects of free stream turbulence were approximately modeled in the turbulence model. Author

**N91-17131*#** National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
**LIQUID BEHAVIOR AT CRITICAL AND SUPERCRITICAL CONDITIONS** **c34**
Huei-huang Chiu (Illinois Univ., Chicago.) and Klaus W. Gross *In* Johns Hopkins Univ., The 26th JANNAF Combustion Meeting, Volume 2 Oct. 1989 p 335-342 (For primary document see N91-17125 09-20)
Avail: NTIS HC/MF A18 CSCL 21H

At a JANNAF workshop, the issue of fluids at and above the critical point was discussed to obtain a better understanding of similar conditions in combustion chambers of rocket engines. Invited experts from academic, industrial, and government institutions presented the most recent physical, numerical, and experimental advances. During the final discussion period, it was agreed that: (1) no analytical capability exists to simulate subject conditions; (2) mechanisms reflected by opalescence, the solubility of gases, other interfacial phenomena listed, and fluorescence diagnostics are new and important; (3) multicomponent mixtures, radiation, critical fluctuation, and other recorded ones pose unknown effects; and (4) various identified analytical and experimental actions must be initiated in a mutually supporting sequence. Author

**N91-17132*#** National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
**RADIATION EFFECTS ON FLOW CHARACTERISTICS IN COMBUSTION CHAMBERS**
M. Q. Brewster (Illinois Univ., Urbana-Champaign.) and Klaus W. Gross *In* Johns Hopkins Univ., The 26th JANNAF Combustion Meeting, Volume 2 Oct. 1989 p 343-353 (For primary document see N91-17125 09-20)
Avail: NTIS HC/MF A18 CSCL 21H

A JANNAF sponsored workshop was held to discuss the importance and role of radiative heat transfer in rocket combustion chambers. The potential impact of radiative transfer on hardware

design, reliability, and performance was discussed. The current state of radiative transfer prediction capability in CFD modeling was reviewed and concluded to be substantially lacking in both the physical models used and the radiative property data available. There is a clear need to begin to establish a data base for making radiation calculations in rocket combustion chambers. A natural starting point for this effort would be the NASA thermochemical equilibrium code (CEC). Author

**N91-17133** Pennsylvania State Univ., University Park.
**MEASUREMENT OF THE VELOCITY-COUPLED ADMITTANCE IN A SOLID PROPELLANT ROCKET MOTOR Ph.D. Thesis**
In-Seung Chung 1989 131 p
Avail: Univ. Microfilms Order No. DA9018196

The experiment attempted to measure the velocity-coupled admittance of solid propellants by a direct measurement of oscillating velocities. The velocity-coupled admittance is a critical parameter for combustion stability of solid propellant rocket motors. Since the velocity-coupled admittance was defined as the complex ratio of the oscillatory mass-flow velocity from the burning surface of a solid propellant to the oscillatory cross-flow velocity above the surface, these oscillatory velocities were the primary quantities to be investigated to determine the velocity-coupled admittance. The oscillatory velocities were measured simultaneously inside the rectangular chamber with an experimental method based on the magnetic flowmeter, a device that can measure directly the velocity of the ionized gas. The oscillatory flows were created by a rotating fear over the sonic nozzle of the chamber. The modulation was generated at both the resonant and nonresonant mode frequencies for comparison of the modulation effects on the velocity coupling. A numerical analysis was formulated to simulate the flowfield of the oscillating velocities. The governing equations for the oscillatory flowfield were derived from a boundary layer-type equation for a two-dimensional laminar compressible flow with wall transpiration. Numerical results were also compared with the experimental data obtained from the actual hot gas tests. Dissert. Abstr.

**N91-17134*#** Loyola Coll., Baltimore, MD.
**JTEC PANEL REPORT ON SPACE AND TRANSATMOSPHERIC PROPULSION TECHNOLOGY**
Duane Shelton Aug. 1990 232 p Sponsored by NASA, Washington, DC; DARPA; and DOE
(Grant NSF ECS-89-02528)
(NASA-CR-187670; NAS 1.26:187670; PB90-215732) Avail: NTIS HC/MF A11 CSCL 21H

An assessment of Japan's current capabilities in the areas of space and transatmospheric propulsion is presented. The report focuses primarily upon Japan's programs in liquid rocket propulsion and in propulsion for spaceplanes and related transatmospheric areas. It also includes brief reference to Japan's solid rocket programs, as well as to supersonic air-breathing propulsion efforts that are just getting underway. The results are based upon the findings of a panel of U.S. engineers made up of individuals from academia, government, and industry, and are derived from a review of a broad array of the open literature, combined with visits to the primary propulsion laboratories and development agencies in Japan. GRA

**N91-17135*#** Aerojet-General Corp., Sacramento, CA. Propulsion Div.
**TEST PLAN PRESSURE FED THRUST CHAMBER TECHNOLOGY**
Glenn Dunn Nov. 1990 102 p
(Contract NAS8-37365)
(NASA-CR-184083; NAS 1.26:184083; KGG4-TP-1; RPT/E0070.66A) Avail: NTIS HC/MF A06 CSCL 21H

Aerojet is developing the technology for the design of a reliable, low cost, efficient, and lightweight LOX/RP-1 pressure fed engine. This technology program is a direct result of Aerojet's liquid rocket booster (LRB) study and previous NASA studies that identified liquid engines using high bulk density hydrocarbon fuels as very attractive for a space transportation system (STS). Previous large thrust LOX/RP-1 engine development programs were characterized by costly development problems due to combustion instability damage. The combustion stability solution was typically obtained through trial and error methods of minimizing instability damage by degrading engine performance. The approach to this program was to utilize existing and newly developed combustion analysis models and design methodology to create a thrust chamber design with features having the potential of producing reliable and efficient operation. This process resulted in an engine design with a unique high thrust-per-element OFO triplet injector utilizing a low cost modular approach. Cost efficient ablative materials are baselined for the injector face and chamber. Technology demonstration will be accomplished through a hot fire test program using appropriately sized subscale hardware. This subscale testing will provide a data base to supplement the current industry data bank and to anchor and validate the applied analysis models and design methodology. Once anchored and validated, these analysis models and design methodology can be applied with greatly increased confidence to design and characterize a large scale pressure fed LOX/RP-1 thrust chamber. The objective of this test program is to generate a data base that can be used to anchor and validate existing analysis models and design methodologies and to provide early concept demonstration of a low cost, efficient LOX/RP-1 thrust chamber. Test conditions and hardware instrumentation were defined to provide data sufficient to characterize combustion stability, performance, and thermal operation over a wide thrust chamber throttling range. Author

**N91-17136#** National Inst. of Standards and Technology, Gaithersburg, MD. Electricity Div.
**METROLOGY FOR SPACE POWER: METROLOGY DEVELOPMENT AND SURVEY OF SPACE-BASED MEASUREMENTS Interim Progress Report**
G. J. FitzPatrick, J. K. Olthoff, E. D. Simmon, and C. P. Fenimore, Jr. Sep. 1990 76 p Sponsored by DNA, Alexandria, VA
(PB91-107607; NISTIR-4422) Avail: NTIS HC/MF A05 CSCL 10B

The technical progress in three investigations which make up the project SDI Measurement Techniques is presented. The first investigation develops part of the mathematical background needed for assessing the reliability and efficiency of the diagnostics used in the development of pulsed power components and systems. The signature of measurement failure is demonstrated in an electro-optic system. The detection of such failures is the first stage in remotely restoring the integrity of a measurement system. The second investigation assesses the applicability of magneto-optic sensors for measuring microsecond and submicrosecond current pulses. The results of comparative measurements of fiber optic current sensors with conventional detectors are reported. The third investigation involves the accumulation of existing information necessary to support an effective measurement development program. The results of an in-depth study of existing space-based measurement techniques are reported. Author

**N91-17137** Pennsylvania State Univ., University Park.
**FIRST-ORDER SINGULAR THRUST-ARCS IN AEROSPACE TRAJECTORY OPTIMIZATION Ph.D. Thesis**
Isaac Michael Ross 1990 136 p
Avail: Univ. Microfilms Order No. DA9032370

The set of extremal intermediate thrust-arcs of an arbitrary Mayer problem of a very general aerospace vehicle is introduced. In the presence of atmospheric forces, the extremal is a first order singular arc. Using Lie brackets, the general form of the singular control is derived. An effort is made to express the control in state variable feedback form. Partial success is achieved when the generality of the system is classified under the following three types: (1) aerodynamically blunt body in a central gravitational field; (2) lifting body in a uniform gravity field; and (3) lifting body in an inverse square gravitational field. Each of these problems is considered under a separate chapter heading and several results are established, including the nonoptimality of the quasi-steady-state trajectory generated by equating thrust and drag. In addition, three bang-bang theorems are proven and they are

readily applicable to an orbiting platform, Goddard's problem, and the problem of maximum endurance of an aircraft. The theorems are doubly verified through reduction to established results and through sample numerical case studies. On the basis of these results, arguments are put forth to lend credibility to the nonoptimality of the aerocruise maneuver. A new bang-bang type maneuver, the aerobang, is proposed and its superiority over the aerocruise established through similar heuristic arguments. Sample computations for a typical hypervelocity vehicle confirm this. The final chapter provides directions for further study to globalize the results. Dissert. Abstr.

**N91-17138*#** Auburn Univ., AL. Space Power Inst.
**THERMAL STORAGE ADVANCED THRUSTER SYSTEM (TSATS) EXPERIMENTAL PROGRAM Final Report, 12 Mar. - 11 Dec. 1990**
M. Frank Rose and Michael E. Lisano, II 4 Feb. 1991 19 p (Grant NAG3-1155)
(NASA-CR-187880; NAS 1.26:187880) Avail: NTIS HC/MF A03 CSCL 21H

The Thermal Storage Advanced Thruster System (TSATS) rocket test stand is completely assembled and operational. The first trial experimental runs of a low-energy TSATS prototype rocket was made using the test stand. The features of the rocket test stand and the calibration of the associated diagnostics are described and discussed. Design and construction of the TSATS prototype are discussed, and experimental objectives, procedures, and results are detailed. Author

**N91-17139*#** Thiokol Corp., Brigham City, UT. Space Operations.
**RSRM-13 (360Q013) BALLISTICS MASS PROPERTIES FLIGHT DESIGNATION STS-41 Final Report**
Brian A. Laubacher and M. C. Richards 11 Dec. 1990 35 p (Contract NAS8-30490)
(NASA-CR-184092; NAS 1.26:184092; TWR-17552-10) Avail: NTIS HC/MF A03 CSCL 21H

The propulsion performance and reconstructed mass properties data from Thiokol's RSRM-13 motors which were assigned to the STS-41 launch are presented. The SRM propellant, TP-H1148, is a composite type solid propellant, formulated of polybutadiene acrylic acid acryonitrile terpolymer binder, epoxy curing agent, ammonium perchlorate oxidizer, and aluminum powder fuel. A small amount of burning rate catalyst (iron oxide) was added to achieve the desired propellant burn rate. The propellant evaluation and raw material information are also presented. The presented ballistic performance was based on the Operational Flight Instrumentation. The adjustments made to the raw data on this flight include biasing the data to correct ambient pressure before liftoff. The performance from each motor as well as matched pair performance values were well within the CEI Specification requirements. Y.S.

**N91-17140*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
**PROPULSION RESEARCH ON THE HYBRID PLUME ROCKET Final Technical Report, 1 Sep. 1989 - 31 Jan. 1990**
F. R. Chang-Diaz and T. F. Yang (Massachusetts Inst. of Tech., Cambridge.) 20 Sep. 1990 28 p
(Grant AF-AFOSR-0345-89; AF Proj. 2308)
(NASA-TM-103372; NAS 1.15:103372; AD-A229163; AFOSR-90-1137TR) Avail: NTIS HC/MF A03 CSCL 22/2

The propagation of RF waves launched in the end cell and central of the tandem mirror propulsion device was investigated both theoretically and experimentally. Theoretically, a computer code was developed to study the wave propagation in a nonhomogeneous magnetic field. It was found that the amplitude of the wave excited in the plasma peaked while approaching the resonance, but then damped out, indicating strong absorption of the wave by the plasma. The absorption took place near the axis and midplane of the device. The experimental results confirmed the theoretical prediction of the phenomena of the resonance effect. This means that the RF power is heating the plasma in center contrary to the earlier prediction that the heating was near the edge. Therefore higher efficiency can be possible. A very important discovery of this experiment was the broadening of the ICRF Fourier spectrum in the presence of the plasma. GRA

# 23 CHEMISTRY AND MATERIALS (GENERAL)

**N91-17141*** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**SUBSTITUTED 1,1,1-TRIARYL-2,2,2-TRIFLUOROETHANES AND PROCESSES FOR THEIR SYNTHESIS Patent**
William B. Alston, inventor (to NASA) and Roy F. Gratz, inventor (to NASA) 27 Mar. 1990 10 p Filed 30 Dec. 1988 Division of US-Patent-Appl-SN-159071, filed 23 Feb. 1988 which is a division of US-Patent-Appl-SN-924474, filed 29 Oct. 1986
(NASA-CASE-LEW-14345-3; US-PATENT-4,912,238; US-PATENT-APPL-SN-292049; US-PATENT-APPL-SN-159071; US-PATENT-APPL-SN-924474; US-PATENT-CLASS-552-101; INT-PATENT-CLASS-C07C-15/16) Avail: US Patent and Trademark Office CSCL 07A

Synthetic procedures to tetraalkyls, tetraacids and dianhydrides substituted 1,1,1 triaryl 2,2,2 trifluoroethanes which comprises: (1) 1,1 bis (dialkylaryl) 1 aryl 2,2,2 trifluoroethane, (2) 1,1 bis (dicarboxyaryl) 1 aryl 2,2,2 trifluoro ethane or (3) cyclic dianhydride of diamine of 1,1 bis (dialkylaryl) 1 aryl 2,2,2 trifluoro ethanes. The synthesis of (1) is accomplished by the condensation reaction of an aryltrifluoromethyl ketone with a dialkylaryl compound. The synthesis of (2) is accomplished by oxidation of (1). The synthesis dianhydride of (3) is accomplished by the conversion of (2) to its corresponding cyclic dianhydride. The synthesis of the diamine is accomplished by the similar reaction of an aryltrifluoromethyl ketone with aniline or alkyl substituted or disubstituted anilines. Also, other derivatives of the above are formed by nucleophilic displacement reactions.
Official Gazette of the U.S. Patent and Trademark Office

# 24 COMPOSITE MATERIALS

Includes physical, chemical, and mechanical properties of laminates and other composite materials.
For ceramic materials see *27 Nonmetallic Materials.*

**N91-17142** British Petroleum Co. Ltd., London (England).
**PRODUCTION OF HIGH SURFACE AREA CARBON FIBRES Patent Application**
Gary James Audley, inventor (to British Petroleum Co. Ltd.) and Alan Grint, inventor (to British Petroleum Co. Ltd.) 14 Oct. 1988 4 p
(EP-PATENT-0-312-395-A2; EP-PATENT-APPL-SN-88309674-5; INT-PATENT-CLASS-D01F-11/10; ETN-90-97969) Avail: UK Patent Office, 254 Southampton Buildings, London WC2A 1A4, England

A patent is claimed for an invention relating to the preparation of high surface area carbon fibers. High surface area carbon fibers are produced by heating carbon fibers in the presence of a quantity of alkali metal hydroxide in excess of 50 percent by weight based on weight of carbon at temperatures above 500 C in an inert atmosphere. The invention is described by reference to comparative test examples. ESA

**N91-17143*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**METCAN SIMULATION OF CANDIDATE METAL MATRIX COMPOSITES FOR HIGH TEMPERATURE APPLICATIONS**
Ho-Jun Lee Nov. 1990 21 p
(NASA-TM-103636; E-5813; NAS 1.15:103636) Avail: NTIS HC/MF A03 CSCL 11D

The METCAN (Metal Matrix Composite Analyzer) computer code is used to simulate the nonlinear behavior of select metal matrix

composites in order to assess their potential for high temperature structural applications. Material properties for seven composites are generated at a fiber volume ratio of 0.33 for two bonding conditions (a perfect bond and a weak interphase case) at various temperatures. A comparison of the two bonding conditions studied shows a general reduction in value of all properties (except CTE) for the weak interphase case from the perfect bond case. However, in the weak interphase case, the residual stresses that develop are considerably less than those that form in the perfect bond case. Results of the computational simulation indicate that among the metal matrix composites examined, SiC/NiAl is the best candidate for high temperature applications at the given fiber volume ratio. Author

**N91-17144#** Air Force Materials Lab., Wright-Patterson AFB, OH. Structural Materials Branch.
**THE EFFECT OF JET FUEL EXPOSURE ON ADVANCED AEROSPACE COMPOSITES 2: MECHANICAL PROPERTIES Final Report, May - Dec. 1989**
David B. Curliss and Diana M. Carlin Aug. 1990 26 p
(AF Proj. 2419)
(AD-A227529; WRDC-TR-90-4064) Avail: NTIS HC/MF A03
CSCL 21/4

The sensitivity of several advanced aerospace composite materials to military jet fuel, JP-4, was investigated in this study. The following commercially available fiber/matrix prepreg materials were used in this investigation: AS-4/3501-6; IM7/8551-7A; IM7/977-2 (1377-2T); IM7/5250-4; IM8HTA; and AS-4/PEEK-(APC-2). The materials were chosen as representative state-of-the-art materials in their classes of standard epoxy, toughened epoxy, toughened BMI, and thermoplastic matrix composites respectively. The materials were processed into (+ or - 45)2S, (0)12T laminates using the manufacturer's recommended process cycle and standard quality assurance checks were performed on the panels. Standard geometry coupons were fabricated from the panels and divided into a control set and test set. The test coupons were immersed in JP-4 in a sealed pressure vessel at 180 F. The weight gain was recorded as a function of the square root of time and the jet fuel was exchanged each time the coupon weight was recorded. In general, the thermoset matrix composites did not pick-up significant levels of fuel in any lay-up examined; while the thermoplastics did absorb JP-4. The amount of JP-4 absorbed by the thermoplastic matrix composites was dependent on the lay-up. After 1680 hours of total exposure time the mechanical properties of the coupons were evaluated. GRA

**N91-17145*** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**PROCESS FOR HIP CANNING OF COMPOSITES Patent**
John J. Juhas, inventor (to NASA) 25 Dec. 1990 7 p Filed 9 Nov. 1989 Continuation-in-part of abandoned US-Patent-Appl-SN-326757, filed 21 Mar. 1989
(NASA-CASE-LEW-14990-1; US-PATENT-4,980,126; US-PATENT-APPL-SN-433863; US-PATENT-APPL-SN-326757; US-PATENT-CLASS-419-49; US-PATENT-CLASS-419-8; US-PATENT-CLASS-419-24; US-PATENT-CLASS-419-36; US-PATENT-CLASS-419-37; US-PATENT-CLASS-419-48) Avail: US Patent and Trademark Office CSCL 11D

A single step is relied on in the canning process for hot isostatic pressing (HIP) metallurgy composites. The composites are made from arc sprayed and plasma sprayed monotape. The HIP can is of compatible refractory metal and is sealed at high vacuum and temperature. This eliminates outgassing during hot isostatic pressing.
Official Gazette of the U.S. Patent and Trademark Office

**N91-17146** Rensselaer Polytechnic Inst., Troy, NY.
**ANALYSIS OF PROGRESSIVE DAMAGE IN FIBROUS COMPOSITE LAMINATES Ph.D. Thesis**
Abdolmehdi Kaveh-Ahangar 1990 267 p
Avail: Univ. Microfilms Order No. DA9031800

A model of a cracked laminate which consisted of three layers of fibrous composite materials where the middle layer is a 90 degree ply and contains an infinite row of equally spaced transverse cracks and the outer layers have arbitrary fiber orientations was proposed to study the progressive transverse cracking phenomena in multi-layered laminates. In order to study first ply failure in fibrous composite laminates, it was assumed that a microcrack which resembles a slit crack exists in the ply undergoing cracking. The constructed admissible stress field in the tiplet at dilute crack density was utilized to calculate the energy release rate of the microcrack. The thickness of the ply undergoing cracking, fiber orientation, and thickness of its adjacent plies were included in the analysis. Then, linear elastic fracture mechanics was used to predict the strength of a typical ply. The residual thermal stresses were also included in the analysis. The classical laminated plate theory was used to calculate the complementary energy of the cracked triplet in terms of its unknown effective thermoelastic properties and those of its damaged middle layer. The complementary energy of the tripiet was also calculated in terms of the local properties of each layer of the triplet, from the constructed admissible stress fields. After calculating the thermoelastic properties of the damaged triplet, the thermoelastic properties of the damaged middle layer of the triplet were extracted from the relations between them which was obtained through the classical laminated plate theory. The energy release rate of a microcrack in the ligament between two existing cracks was calculated based on the constructed admissible stress fields. The effect of the crack density in the ply undergoing progressive cracking, the location of the microcrack, and fiber orientation of the adjacent plies were included in the analysis. The calculated energy release rate and linear elastic fracture mechanics were used to study progressive cracking in several laminates.
Dissert. Abstr.

**N91-17147** Pennsylvania State Univ., University Park.
**FABRICATION AND DESIGN OF SILICON CARBIDE WHISKER-REINFORCED MULLITE COMPOSITES Ph.D. Thesis**
Taewoo Kim 1990 120 p
Avail: Univ. Microfilms Order No. DA9032314

Laminated, silicon carbide whisker reinforced mullite composites were designed and fabricated. Mullite powder was blended with silicon carbide whiskers in an organic slurry for tape casting into thin lamina of various whisker loadings. The laminas were then arranged into laminated plates and densified by hot pressing. The laminates were designed to improve the thermo-mechanical behavior for high temperature applications, based upon the measured properties of individual laminas and the laminate plate theory. Optimized laminate design, with minimum core residual tensile stress and sufficiently deep surface-layer of residual compressive stress, yielded a large improvement in fracture strength. The elastic properties and residual stresses of the designed laminated were evaluated experimentally and compared with those predicted using the laminate plate theory. The measured residual stresses in the laminates agreed well with the predicted values. Thermal shock resistance in mullite, monolithic composite laminate and optimized composite laminates was evaluated by water quenching samples to produce temperature differences ranging from 100 to 1100 C. The thermal shock resistance was determined from the change in Young's modulus and fracture strength. Based on the measured properties, the thermal shock initiation resistance parameter (R) was calculated and compared with the value observed experimentally. Finite element methods were used to predict the effectiveness of the optimized composite laminates to increase fracture strength and thermal shock resistance over monolithic mullite. Dissert. Abstr.

**N91-17148** Pennsylvania State Univ., University Park.
**ELASTIC WAVES IN STRUCTURALLY CHIRAL COMPOSITES Ph.D. Thesis**
Shiuh-Kuang Yang 1990 129 p
Avail: Univ. Microfilms Order No. DA9032399

Elastic wave propagation through structurally chiral (handed) media was studied. The primary objectives are to construct structurally chiral composites and to characterize their properties.

Structurally chiral composites are constructed by stacking identical uniaxial plates, whose consecutive symmetric axes describe either a right- or a left-handed spiral. A matrix representation method is used to solve the elastic wave propagation in such layered composites. Numerical computation of the plane wave reflection and transmission characteristics for chiral arrangements are compared with those for the non-chiral one. It is concluded that the co-polarized characteristics are unaffected by the structural chirality, while the cross-polarized reflected and transmitted fields are greatly influenced by it. Numerical modeling is also applied for the real samples. The polarization ellipse of the transmitted field of each sample is calculated. To verify the form chirality, four glass-reinforced chiral and non-chiral composite samples are made from helix tape, molded, debulked, and cured individually under identical temperature and pressure histories. The spiral composites are characterized using shear and longitudinal wave transducers in ultrasonic experiments. Both the material properties and the polarization ellipse of the transmitted field of each sample are measured. It is proved conclusively that left and right handedness in the microstructures of a material rotates the plane of polarization of a propagating shear wave in the opposite directions. Thus it is now possible to say that by reducing the length scale of the handed microstructures tone more appropriate to its propagating wavelength, a medium is obtained that gives rise to effects similar to optical radar and optical dichroism. Dissert. Abstr.

**N91-17149#** Harvard Univ., Cambridge, MA. Div. of Applied Sciences.
**A MODEL FOR LOAD-TRANSFER FROM AN EMBEDDED FIBER TO AN ELASTIC MATRIX**
William S. Slaughter and J. Lyell Sanders, Jr. Aug. 1990 22 p
(Contracts N00014-86-K-0753; N00014-90-J-1377)
(AD-A228466; MECH-162) Avail: NTIS HC/MF A03 CSCL 11/10

A model is presented for approximating load diffusion from axially loaded fibers embedded in elastic matrices. The fundamental elastostatic solutions used are for a point force and point dilation in either a fully-infinite or semi-infinite space. Tangential tractions across the fiber-matrix interface are included explicitly in the analysis. The model is applied to the 3-D analogs of Melan's first problem and Reissner's problem and comparisons are made with exact results in the case of the former to help establish the validity of the model. The ability to analyze load transfer in fiber-matrix systems which are illustrative of those that exist in fiber reinforced materials is fundamental to the study of how such materials behave in application. The ability at present, however, to rigorously solve such problems in the realm of 3-D elasticity is limited to a few isolated results involving infinite fibers bounded along their entire length to full-infinite matrices. GRA

**N91-17150#** California Univ., Berkeley. Lawrence Berkeley Lab.
**MICROSTRUCTURE AND STABILITY COMPARISON OF NANOMETER PERIOD W/C, WC/C, AND Ru/C MULTILAYER STRU TURES**
Tai D. Nguyen, Ronald Gronsky, and Jeffrey B. Kortright Apr. 1990 14 p Presented at the Spring Meeting of the Materials Research Society, San Francisco, CA, 16-21 Apr. 1990 Prepared in cooperation with California Univ., Berkeley
(Contracts DE-AC03-76SF-00098; F49620-87-K-0001)
(DE91-005232; LBL-28064; CONF-900466-93) Avail: NTIS HC/MF A03

Multilayer structures of W/C, WC/C, and Ru/C, of various periods were prepared and studied by high-resolution transmission electron microscopy. Comparison of the phases in the layered structures is made for as-prepared and annealed samples. Both as-prepared and annealed WC/C multilayers are predominantly amorphous, while the phases in the W/C depend on the periods. The 2 nm period W/C multilayer remains amorphous after annealing, and the longer periods recrystallize to form W(sub 2)C. The layered microstructures of W/C and WC/C are stable on annealing at all periods, while the amorphous Ru-rich layers in the 2 nm period Ru/C multilayer agglomerate upon annealing to form elemental hexagonal Ru crystallites. Larger period Ru/C multilayers show stable layered structures, and indicate hexagonal Ru in the Ru-rich layers. X ray measurements show that the multilayer periods expand on annealing for all metal-carbon multilayers studied. DOE

**N91-17151** Washington Univ., Saint Louis, MO.
**COMPRESSIVE STRENGTH AND MODES OF FAILURE IN POLYMERIC COMPOSITES Ph.D. Thesis**
Mohsen M. Sohi 1989 251 p
Avail. Univ. Microfilms Order No. DA9035032

The results are presented of an study on compressive behavior of polymeric composites. Model and real unidirectional composites and quasi-isotropic laminates were used. The model composites consisted of fiber bundles embedded in epoxy matrices and were used to assess the intrinsic strength of fibers. Failure traits were monitored optically and by acoustic emission. The results on model composites were then correlated to those observed in real unidirectional composites. Optical and scanning electron microscopy were used to characterize the mechanism of compressive failure in 11 different real composites. Although different composites showed similar macroscopic features of kinking deformation, the triggering modes of failure were sometimes different. The mechanics of incremental deformations was applied to explain the phenomenon of kink band formation that is often associated with compressive failure of composites and other anisotropic materials. The effect of notches and defects on compressive behavior of quasi-isotropic laminates was determined. Finite element analysis was used to predict the failure stress and the mode of failure in a laminate with cut plies. Dissert. Abstr.

**N91-17152** California Univ., Los Angeles.
**GUIDED WAVES IN FIBER-REINFORCED COMPOSITE LAMINATES Ph.D. Thesis**
Ching-Chung Yin 1990 147 p
Avail: Univ. Microfilms Order No. DA9033932

Guided wave behavior in undamaged as well as damaged fiber-reinforced composite laminates is studied in an effort to develop ultrasonic nondestructive methods for their quantitative characterization. Certain characteristics of composite laminates are determined from the analysis of leaky Lamb wave (LLW) data. The LLW experiment recorded amplitude spectra and time histories of reflected pulses from composite specimens immersed in water and insonified by an acoustic beam. The dispersion curves of leaky guided waves obtained through this experiment are analyzed to characterize the material properties of and internal defects in composite laminates. An approximate solution by ray analysis and the exact solution for a unidirectional composite plate are used to calculate the reflected acoustic fields and explain certain irregularities observed in the data for thick specimens. A global matrix method is implemented to formulate the wave propagation problem and to calculate the reflection coefficients for multilayered angle-ply laminates. A systematic inversion scheme is used to determine the reduction in stiffness due to transverse cracks in the off-axis plies of damaged, multi-orientation laminates from the LLW data. The inversion scheme is based on an iterative least squares method. The convergence zone of the scheme is discussed. The cracked laminae are modeled as either transversely isotropic with weak stiffness or othotropic with an additional symmetry axis perpendicular to the surfaces of the transverse cracks. Excellent agreement between the theoretical results and measured data was achieved in most cases, indicating that the theoretical model of the composite medium is accurate within the framework of linear elasticity. Dissert. Abstr.

**N91-17153** Northwestern Univ., Evanston, IL.
**EFFECT OF INTERFACIAL ZONE ON MECHANICAL BEHAVIOR AND FAILURE OF FIBER-REINFORCED COMPOSITES Ph.D. Thesis**
Han Zhu 1990 124 p
Avail: Univ. Microfilms Order No. DA9032025

The mechanical behavior of the interphase between fibers

and matrix is modeled by continuity of tractions, and a linear relation between displacement differences across the interphase and the conjugate tractions. The proportionality constants characterize the stiffness and the strength of the interphase. By the use of this model, and for transverse loading of rectangular and hexagonal array fiber-reinforced composites, numerical results were obtained for the stresses in the matrix and in the fibers. Variation of the interphase parameters causes pronounced changes in these stress distributions. The initiation, propagation, and arrest of interphase cracks were analyzed based on a criterion of critical strain energy density in the interphase. The results were also used to display the effect of the interphase parameters on the overall elastic moduli of the composite, prior as well as subsequent to the development of interphase cracks. The calculated values were compared with available bounds that were adjusted for interphase stiffness. A fiber with inferior interphase properties generates higher stresses at the fiber matrix interphase of neighboring fibers. Detailed calculations are presented for this effect. For a cell of a composite which contains a cluster of fibers, calculations were performed by the use of boundary element method. The interphase stresses for neighboring fibers were calculated. Also, for the case of the fiber with an interphase crack the strain energy density near the crack tip was calculated and the condition for crack propagation was discussed. The case of a composite with radial matrix cracks was also investigated. The stress intensity factors at the tip of the matrix crack, the reduction of the elastic constant of the composites due to matrix damage, and the strain energy density at the interphase for different matrix crack lengths were calculated. The correlation between the circumferential stress prior to the development of radial matrix cracks and the matrix damage of the composites was also discussed. Dissert. Abstr.

**N91-17154** Drexel Univ., Philadelphia, PA.
**MECHANICAL PROPERTY ENHANCEMENT OF THICKER SECTION THERMOPLASTIC COMPOSITES BY HYBRIDIZATION Ph.D. Thesis**
Subhash Chandra Khatri 1990 241 p
Avail: Univ. Microfilms Order No. DA9030012

With success of composite materials in high performance structures, new structural applications are being identified. This will require use of thicker section thermoplastic composites. Thick section (16, 40, and 80 plies) hybrid polyphenylene sulfide (PPS) matrix composites were evaluated for tensile, flexural, and compressive response. The hybridization of the composite was achieved by using E glass and AS4 graphite fibers. A symmetric sandwich configuration consisting of exterior E glass fibers and AS4 graphite in the core was used to attain improved impact damage response and to enhance the mechanical properties by delaying the failure of the AS4 graphite PPS. Composites of five different AS4 graphite volume fractions and three stacking sequences were evaluated and analyzed. Theoretical predictions based on the classical laminate theory were used to analyze the experimental data. The effect of residual thermal processing stresses was incorporated in the predictions and found to be negligible. In general, the composites showed a poor compressive response as compared to their tensile strengths. Dissert. Abstr.

**N91-17155** Missouri Univ., Rolla.
**NON-STEADY STATE CRACKING IN UNIDIRECTIONAL COMPOSITES Ph.D. Thesis**
Li Chai 1990 154 p
Avail: Univ. Microfilms Order No. DA9032099

The response of composite materials containing flaws under applied loads must be well understood for efficient use of these materials in structural applications. Based on the shear lag theories, analytical models were developed for displacement measurement and stress distributions in a finite fiber reinforced unidirectional composite material with various damage configurations. The models are applicable for strong matrix composites as well as soft matrix composites. The fiber and matrix stresses are established as functions of the applied load, crack geometry, and microstructural properties of the constituents. From the predicted stresses, the mode of failure is studied according to a maximum point stress criterion and a comparison is made to show the difference in the fracture behavior of typical composite materials. Dissert. Abstr.

**N91-17156** Drexel Univ., Philadelphia, PA.
**ELASTIC BEHAVIOR OF 3-D BRAIDED COMPOSITES UNDER COMPRESSIVE LOADING Ph.D. Thesis**
David Liao 1990 180 p
Avail: Univ. Microfilms Order No. DA9030013

A systematically conducted experiment was carried out to characterize the compressive properties of 3-D braided composites. Two analytical models were also modified and incorporated into finite element codes to predict the elastic behavior of 3-D braided composites under compressive loading. On the experimental characterization, three different composite systems, each reinforced by carbon, S-2 glass, and Kevlar fibers, respectively, were employed to study the material effect on the compressive properties. Four different braided structures were used to study the effect of fiber architecture. In addition, two compression test fixtures, namely, the shear-loaded fixture (IITRI) and the end-loaded fixture, were used. The experimental results reveal that fiber architecture plays a significant role in carbon and S-2 glass braided composites under compressive loading. Kevlar composites are not sensitive to fiber architecture. The compressive strength and modulus of braided composites are comparable with those of equivalent (+/-theta/O) laminates. In theoretical analysis, two models are used to predict the elastic behavior of 3-D braided composites under compressive loading. The fabric geometry model (FGM) based on the micromechanics of composite materials and the finite cell model (FCM) based on a frame-truss structural finite element method were modified and implemented into finite element codes. In general, the fabric geometry model is seen to yield much better predictions than the finite cell model does. For carbon and S-2 glass braided composites, FGM predictions of all properties agree quite well with the experimental results for all four different braiding percentages. The FCM, on the other hand, works only for composites with lower (25 or 50 percent) braiding percentage. Besides, neither the FGM or the FCM accounts for the non-linear behavior of Kevlar braided composites. Dissert. Abstr.

**N91-17157*#** Old Dominion Univ., Norfolk, VA. Dept. of Mechanical Engineering and Mechanics.
**IMPACT RESPONSE OF COMPOSITE MATERIALS Progress Report, period ended 31 Jan. 1991**
S. N. Tiwari and K. Srinivasan Feb. 1991 57 p
(Grant NAG1-569)
(NASA-CR-187896; NAS 1.26:187896) Avail: NTIS HC/MF A04 CSCL 11D

Composite materials composed of carbon fibers and resin matrices offer great promise in reducing the weight of aerospace structures. However they remain extremely vulnerable to out of plane impact loads, which lead to severe losses in strength and stiffness. The results of an experimental program, undertaken to investigate the low velocity impact damage tolerance of composite materials is presented. The objectives were to identify key neat resin/composite properties that lead to enhancement of composite impact damage tolerance and to find a small scale test that predicts compression after impact properties of panels. Five materials were selected for evaluation. These systems represented different classes of material behavior such as brittle epoxy, modified epoxies, and amorphous and semicrystalling thermoplastics. The influence of fiber properties on the impact performance was also studied in one material, i.e., in polyether ether ketone (PEEK). Several 24 and 48 ply quasi-isotropic and 24 ply orthotropic laminates were examined using an instrumented drop weight impactor. Correlations with post impact compression behavior were made. Author

**N91-17158#** Northwestern Univ., Evanston, IL. Dept. of Materials Science and Engineering.
**TAILORED INTERFACES FOR METAL-MATRIX COMPOSITES: FUNDAMENTAL CONSIDERATIONS Annual Technical Report, 1 Oct. 1989 - 30 Sep. 1990**
Morris E. Fine and Julia R. Weertman 31 Oct. 1990 61 p

(Grant AF-AFOSR-0043-89; AF Proj. 2306)
(AD-A229143; AFOSR-90-1151TR) Avail: NTIS HC/MF A04 CSCL 11/4

The objective of this research is to determine the interface properties needed for successful metal matrix composites and to learn how to achieve these properties. A number of factors have been selected for the study. These are thermodynamic stability of the interface, nature of the bonding across the interface, energy and structure of the interface, and role of adsorption at the interface. A number of systems have been chosen to probe these factors: Al/TiC, Al/alpha-Al2O3, Al/MgAl2O4(spinel), Al/Al3(Tix, Zr1-x), Mg/SiC, Mg/MgO, and Mg/Al2O3. Techniques for preparing all of these composites have been worked out, including mechanical alloying followed by extrusion, arc melting, and liquid metal infiltration. MMCs also were obtained from Martin Marietta and Dow. Microstructures of the resulting MMCs are presented and discussed along with preliminary studies of some of the interfaces using transmission electron microscopy. In comparison to Al/SiC, Al/TiC and Mg/SiC show no evidence of chemical reaction at the interface during processing. Al/MgAl2O4(spinel) has superior mechanical properties to Al/alpha-AlO3, both prepared identically. GRA

**N91-17159#** Materials Research Society, Pittsburg, PA.
**MATERIALS RESEARCH SOCIETY SYMPOSIUM PROCEEDINGS: POLYMER BASED MOLECULAR COMPOSITES, VOLUME 171 Final Report, 26 Nov. 1989 - 25 Nov. 1990**
Dale W. Schaefer, ed. and James E. Mark, ed. (Cincinnati Univ., OH.) Sep. 1990 463 p Symposium held in Boston, MA, 27-30 Nov. 1989
(Grant AF-AFOSR-0089-90; AF Proj. 2303)
(AD-A229199; AFOSR-90-1054TR-VOL-171) Avail: NTIS HC/MF A20 CSCL 07/6

A symposium entitled, Polymer Based Molecular Composites, was organized as part of the Materials Research Society Fall Meeting held November 27 to 30, 1989 in Boston, Massachusetts. A total of 57 papers were presented during the symposium. The papers were arranged in the following eight categories: (1) Inorganics/Emulsions; (2) Emulsions/Blocks; (3) Rigid-Flexible Systems; (4) Blends/IPN's; (5) Ionomers/Structure; (6) Synthesis/Electrooptical Properties; (7) Interfaces/Mechanical Properties; (8) Miscellaneous/Conventional Composites. Two papers were recognized by the symposium organizers with awards as outstanding contributed papers. Two other papers in the symposium were recognized by the Materials Research Society with Graduate Student Awards to their presenters. GRA

# 25 INORGANIC AND PHYSICAL CHEMISTRY

Includes chemical analysis, e.g., chromatography; combustion theory; electrochemistry; and photochemistry.

For related information see also *77 Thermodynamics and Statistical Physics.*.

**N91-17160#** University of Southern Illinois, Carbondale. Dept. of Chemistry and Biochemistry.
**INTERACTIONS OF SULFUR-CONTAINING COMPOUNDS WITH TRANSITION METAL CLUSTERS AND METAL SURFACES III Final Report, 1 Jan. - 31 Dec. 1988**
L. V. Dunkertot, C. C. Hinckley, J. Tyrell, and P. D. Robinson 1989 31 p
(Contract DE-FC22-88PC-88861)
(DE90-010591; DOE/PC-88861/T18) Avail: NTIS HC/MF A03

Reactions of sulfur-containing substituted dibenzothiophenes with transition metals have been continued with emphasis on the nature and type of metal-sulfur bonding, including the effect of the metal on the adjacent bond lengths. The structure of (eta-(sup 5)-cyclopentadienyl) carbonyl 4-P-diphenyl-phosphine dibenzothiophene iron (II) iodide was determined by x ray diffraction. The synthesis of (mu)2 bridged dinuclear Fe(II) complex with 4-thiomethyldibenzothiophene is reported. The structure of the complex dicyclopentadienyl dicarbonyl di-iron dithiomethyl dibenzothiophene was determined by H-1 NMR, C-13 NMR, FTIR, FABMS, and elemental analysis. Interestingly, C-13 NMR and H-1 NMR showed significant shift after complex formation. The structure of 4-S-Methyldibenzothiophene was determined by x ray diffraction. The geometry of 4-S-Methyldibenzothiophene is orthorhombic with planar dibenzothiophene having the methyl sulfide substituent out of plane of the ring. It is hoped through these studies to increase the understanding of the role in-situ metal sulfides play in the coal desulfurization process and to improve predictions of new routes to coal desulfurization. DOE

**N91-17161#** Lawrence Livermore National Lab., CA.
**SHOCK TUBE IGNITION OF ISOMERS OF OCTANE**
Alexander Burcat (Technion - Israel Inst. of Tech., Haifa.), William J. Pitz, and Charles K. Westbrook 13 Dec. 1989 23 p Presented at the 23d International Symposium on Combustion, Orleans, France, 22-27 Jul. 1990
(Contract W-7405-eng-48)
(DE90-005991; UCRL-102497-1; CONF-900704-1) Avail: NTIS HC/MF A03

Ignition delay time measurements were carried out behind reflected shock waves for three isomers of octane, including n-octane, 2,2,4-trimethyl pentane, and 2,3,4-trimethyl pentane, and for 1-octene. Initial concentrations of fuel, oxygen, and argon, and the post-shock temperature were varied systematically to establish the influences of these parameters on ignition delay time. A detailed chemical kinetic reaction mechanism was developed to interpret the experimental results. Overall agreement between experimental and computed results was very good, and the model was used to describe the elementary reaction paths by which these fuels ignite and kinetic differences between these closely related hydrocarbon fuels. DOE

**N91-17162#** Lawrence Livermore National Lab., CA.
**ENGINE KNOCK PREDICTIONS USING A FULLY-DETAILED AND A REDUCED CHEMICAL KINETIC MECHANISM**
J. S. Cowart, J. C. Keck, J. B. Heywood (Massachusetts Inst. of Tech., Cambridge.), Charles K. Westbrook, and William J. Pitz 13 Dec. 1989 23 p Presented at the 23d International Symposium on Combustion, Orleans, France, 22-27 Jul. 1990
(Contract W-7405-eng-48)
(DE90-005992; UCRL-102495; CONF-900704-2) Avail: NTIS HC/MF A03

Two chemical kinetic models are used to interpret engine knock data obtained in a laboratory internal combustion engine. These consisted of a detailed kinetic model and a reduced kinetic model, both calibrated to describe engine conditions. Comparisons of both models with experimental results are discussed. Relationships between the reaction steps of the detailed and reduced models are examined in detail, and the relative strengths and weaknesses of the two approaches are discussed. DOE

**N91-17163#** Lawrence Livermore National Lab., CA.
**KINETIC MODELING OF ETHENE OXIDATION AT LOW AND INTERMEDIATE TEMPERATURES**
Richard D. Wilk, William J. Pitz, Charles K. Westbrook, and Nicholas P. Cernansky (Drexel Univ., Philadelphia, PA.) 13 Dec. 1989 18 p Presented at the 23d International Symposium on Combustion, Orleans, France, 22-27 Jul. 1990
(Contracts W-7405-eng-48; DE-FG04-87AL-44658)
(DE90-005998; UCRL-102494; CONF-900704-5) Avail: NTIS HC/MF A03

A detailed chemical kinetic mechanism for ethene oxidation has been developed and used to model intermediate temperature oxidation chemistry. The model was used to simulate the reactions in a static reactor at temperatures of 696 and 718 K, an equivalence ratio of 2.0, and a pressure of 600 torr. Modeling results at these conditions were compared with experimental species concentration data. The calculated concentrations of the major products ethene oxide and carbon monoxide are in very good agreement with the experimental data. The calculated maximum concentrations of

formaldehyde and methanol are slightly low, but the shapes of the profiles follow closely the experimental species histories. The calculated methane concentrations are in good agreement in the early stages of the reaction, but are overpredicted in the latter stages. The predicted carbon dioxide levels are low in the early stages of the reaction. The modeling calculations identified some of the key reaction steps at the present conditions. The addition of HO2 and OH radicals to ethene and their subsequent reactions are responsible for the formation of the majority of the reaction intermediates. DOE

**N91-17164#** Union Carbide Corp., Tarrytown, NY.
**OXYGEN ENRICHED COMBUSTION SYSTEM PERFORMANCE STUDY, VOLUME 4, PHASE 1 Final Report**
M. A. Delano and Y. Kwan (Energy and Environmental Research Corp., Irvine, CA.) Jul. 1989 19 p
(Contract DE-AC07-85ID-12597)
(DE90-011477; DOE/ID-12597/4-VOL-4-PHASE-1) Avail: NTIS HC/MF A03

The current study was undertaken to evaluate the performance of a pressure swing adsorption (PSA) oxygen plant to provide oxygen for industrial combustion applications. PSA oxygen plants utilize a molecular sieve material to separate air into an oxygen rich product stream and a nitrogen rich exhaust stream. These plants typically produce 90 to 95 percent purity oxygen and are located in close proximity to the point of use. In contrast, high purity (99.999 percent) oxygen is produced by the distillation of liquid air at a remote plant and is usually transported to the point of use either as a cryogenic liquid in a tank trailer or as a high pressure gas via pipeline. In this study, experiments were performed to the test PSA system used in conjunction with an A burner and comparisons were made with the results of the previous study which utilized high purity liquid oxygen. DOE

**N91-17165#** California Univ., Berkeley. Lawrence Berkeley Lab. Materials and Chemical Sciences Div.
**VACUUM ULTRAVIOLET SPECTROSCOPY AND DYNAMICS**
Y. T. Lee and A. H. Kung Mar. 1990 5 p Presented at the 1990 Combustion Research Contractors' Meeting, Granlibakken, CA, 6-8 Jun. 1990
(Contract DE-AC03-76SF-00098)
(DE90-011601; LBL-28722-ABS; CONF-9006187-2) Avail: NTIS HC/MF A01

The primary focus of this project is to develop and apply novel spectroscopic techniques in the UV and VUV region to the understanding of molecular dynamical processes at the microscopic level. The approach is to apply a recently developed high-resolution laser source to obtain and analyze photoionization and photoelectron spectra of jet-cooled species and of reaction products resulting from unimolecular or bimolecular dissociation processes. DOE

**N91-17166#** California Univ., Berkeley. Lawrence Berkeley Lab. Materials and Chemical Sciences Div.
**TUNABLE FAR INFRARED LASER SPECTROSCOPY OF VAN DER WAALS BONDS: Ar-NH3 Ph.D. Thesis**
Dz-Hung Gwo Nov. 1989 268 p Prepared in cooperation with California Univ., Berkeley
(Contract DE-AC03-76SF-00098)
(DE90-011613; LBL-28449) Avail: NTIS HC/MF A12

Hyperfine resolved vibration-rotation-tunneling spectra of Ar-NH3 and (NH3)2, generated in a planar supersonic jet, were measured with the Berkeley tunable far infrared laser spectrometer. Among the seven rotationally assigned bands, one band belongs to Ar-NH3, and the other six belong to (NH3)2. To facilitate the intermolecular vibrational assignment for Ar-NH3, a dynamics study aided by a permutation-inversion group theoretical treatment is performed on the rovibrational levels. The rovibrational quantum number correlation between the free internal rotor limit and the semi-rigid limit is established to provide a basic physical picture of the evolution of intermolecular vibrational component states. An anomalous vibronically allowed unique Q branch vibrational band structure is predicted to exist for a near prolate binary complex containing an inverting subunit. According to the model developed in this work, the observed band of Ar-NH3 centered at 26.470633(17)/cm can correlate only to either the fundamental dimeric stretching band for the A(sub 2) states with the NH3 inversional quantum number v(sub i) = 1, or the K(sub a) = 0 (l arrow) 0 reverse yields 0 subband of the lowest internal-rotation inversion difference band. Although the estimated nuclear quadrupole coupling constant favors a tentative assignment in terms of the first possibility, a definitive assignment will require far infrared data and a dynamical model incorporating a potential surface. DOE

**N91-17167#** Oak Ridge National Lab., TN.
**REPORT OF THE STUDY GROUP ON COMPLETE SPECTROSCOPY**
Jerry D. Garrett 1989 16 p Presented at the Symposium on the Nucleus At High Spin (Mainly) Nuclear Structure in the Era of New Spectroscopy, Copenhagen, Denmark, 19-24 Oct. 1989
(Contract DE-AC05-84OR-21400)
(DE90-011647; CONF-8910315-2) Avail: NTIS HC/MF A03

This report summarizes the topics considered in four discussions of about two hours each attended by most of the workshop participants. The contents of the lectures of David Radford, Fumihiko Sakata, Ben Mottelson, and Jerry Garret pertaining to Complete Spectroscopy are contained elsewhere in this proceedings. Most detailed nuclear structure information is derived from measurements of the spectroscopic properties (e.g., excitation energies, angular momenta, parities, lifetimes, magnetic moments, population cross sections, methods of decay, etc.) of discrete nuclear eigenstates. The present instrumentation allows in the best cases such measurements to approach the angular momentum limit imposed by fission and to as many as fifteen different excited bands. In anticipation of the new generation of detection equipment, such as the EUROBall and the GAMMASPHERE, the Complete Spectroscopy Study Group attempted to define the limits to such studies imposed by physical considerations and to consider some of the new, interesting physics that can be addressed from more complete discrete spectroscopic studies. DOE

**N91-17168** Florida State Univ., Tallahassee.
**CONFINED SUPERSONIC MIXING LAYERS: A COMPUTATIONAL INVESTIGATION OF INSTABILITY AND MIXING ENHANCEMENT Ph.D. Thesis**
Fang Qiang Hu 1990 130 p
Avail: Univ. Microfilms Order No. DA9027799

Hydrodynamic instability of a compressible shear mixing layer plays a very important role in controlling and promoting the mixing processes in supersonic combustion problems. At supersonic convective Mach numbers, the natural mixing rates of the shear layer are observed to be very small. The linear spatial instability problem of a supersonic shear mixing layer inside a rectangular channel is solved. A systematic way of calculating and classifying all the normal modes is developed. It is demonstrated that a vortex sheet at high supersonic convective Mach number, neutrally stable when unconfined, becomes unstable when confined. Extensive numerical computations indicate that two classes of unstable supersonic instability waves can be identified. In addition to unstable waves, two families of neutral acoustic waves can also be identified. The characteristics of the unstable waves as well as the neutral waves are determined. It is concluded that the new supersonic instabilities found in this study are the dominant instabilities of a confined mixing layer at high supersonic convective Mach numbers. Thus, they are very relevant to the supersonic combustion problem. The possibility of enhancing the rate of supersonic mixing by means of a periodic Mach wave system is explored. The stability of the periodic basic flow is analyzed numerically by the Floquet theory and the spectral-collocation method. The convergence of the numerical solutions is discussed. New secondary instabilities of the shear layer induced by the periodic Mach waves are found computationally. The growth rate of the new instabilities is found to vary nearly linearly with the

ratio of the wavy wall amplitude to the wave length. Therefore, it is a potentially promising scheme for the enhancement of supersonic mixing. Dissert. Abstr.

**N91-17169** New South Wales Univ., Canberra (Australia).
**THE RECOVERY OF NATURAL GAS CONDENSATES USING MEMBRANE TECHNOLOGY Ph.D. Thesis, Feb. 1989 Abstract Only**
Matthew Brennan 17 May 1990 2 p
Avail: Issuing Activity

The recovery of condensate fractions from natural gas using membrane technology was investigated. Supported liquid membranes made using kerosene and C8 to C16 alkanes immobilized in commercial microporous filters were found to be selective to condensates over methane. For example, a separation factor of 15.0 for propane relative to methane at 22 C at a feed pressure of 360 kPa was found using a kerosene membrane. Supported oil membranes were analyzed using a simple passive solution/diffusion model. Pore size limitations prevented the supported liquid membranes from operating at pressure drops above 750 KPa and an alternative membrane design was developed where the mineral oils were used to swell dense silicone rubber films. The oil swollen silicone rubber membranes were less selective to condensates than the supported liquid membranes. A separation factor of propane relative to methane of 11.0 for a kerosene swollen membrane at ca 360 KPa was obtained. However the membranes were able to operate at pressure drops up to 6000 KPa. Selectivity was found to increase at lower temperatures but a decline in selectivity occurred at high pressures which was attributed partly to loss of the swelling agent from the rubber and partly to less favorable solution thermodynamics. The diffusion behavior of the swollen membranes was analyzed using time lag experiments and interpreted in terms of theories of diffusion in polymers and liquids. A brief comparison of hypothetical process designs using the membranes developed to a simple turbo expander plant indicates that the membrane plant could be more energy efficient but plant design may be complicated by the need to incorporate external refrigeration facilities. Author

**N91-17170** New South Wales Univ., Canberra (Australia).
**THE ROLE OF ORGANIC IMPURITY ADSORPTION ON THE PRECIPITATION OF ALUMINA TRIHYDRATE Ph.D. Thesis, Apr. 1989 Abstract Only**
John Francis Coyne 23 May 1990 3 p
Avail: Issuing Activity

Organic impurities in the Bayer process significantly lower the yield of alumina trihydrate from the precipitation stage. For this reason the adsorption of organic compounds on alumina trihydrate was studied. The cationic surfactant cetyl trimetyl ammonium bromide (CTAB) was shown to adsorb on alumina trihydrate. It was reported that hydroxy organic compounds inhibit the precipitation of alumina trihydrate. Hence the adsorption of hydroxy organic compounds was investigated. In order to study the adsorption of hydroxy organic compounds on alumina trihydrate, a reliable spectrophotometric analytical technique was developed. The technique was based on the alkaline premanganate oxidation of these hydrox organic compounds. Adsorption experiments showed that hydroxy organic compounds did adsorb on alumina trihydrate from caustic aluminate solution. Precipitation experiments confirmed that these compounds also inhibit the precipitation of alumina trihydrate. The organic compounds that were found to adsorb on trihydrate and hence inhibit precipitation, were also shown to adsorb from caustic aluminate solution onto calcined alumina. A process using alumina as the absorbent to remove organic impurities from solution was developed. Preliminary process studies showed that this technology has the potential to produce a significant increase in the rate of trihydrate percipitation, a reduction in the induction period during precipitation, and improved quality of the product tridydrate. Author

**N91-17171** New South Wales Univ., Sydney (Australia). Dept. of Analytical Chemistry.
**STUDIES ON THE OPTIMISATION OF MOBILE PHASE COMPOSITION IN REVERSED-PHASE LIQUID CHROMATOGRAPHY Ph.D. Thesis Abstract Only**
Sojka Sonja Sekulic Apr. 1989 2 p
Avail: Issuing Activity

The objective was to create a more versatile procedure for the optimization of the mobile phase composition in reversed-phase liquid chromatography (RPLC). The effectiveness of the transfer rules employed for the location of isoeluotropic mobile phase was investigated. It was found that these rules were not always accurate in their prediction of isoeluotropic compositions. The simple computer-aided routine was devised to locate isoeluotropic mobile phase. The effects that tailed peaks have on optimization procedures were also investigated. The exponentially modified Gaussian peak shape was found to describe adequately the experimentally observed peak shapes in RPLC. Author

**N91-17172#** North Carolina Univ., Chapel Hill. Dept. of Chemistry.
**CHEMICAL ACTIVATION OF METHANE Annual Report, 1 May 1989 - 30 Apr. 1990**
Maurice Brookhart 31 May 1990 64 p
(Contract GRI-5087-260-1596)
(PB90-270455; GRI-90/0183) Avail: NTIS HC/MF A04 CSCL 07D

A strategy is described for the preparation of transition metal methane complexes. These complexes were designed to study coordinatively unsaturated, high electrophilic transition metal complexes containing monodentate and bidentate perfluoroalkyl phosphines which are soluble in totally inert perfluoroalkane solvents. The preparation and spectroscopic characterization of several precursor complexes is described. The complexes involve low valent perfluoroalkyl phosphine derivatives of iron, chromium, and molybdenum. Preliminary experiments indicate a highly reactive, electrophilic 16-electron unsaturated species can be generated from the precursor complexes by photolysis. Hydrocarbon complexes (including the methane complex) were studied by nanosecond transient absorption laser spectroscopy. Preliminary results are reported on the synthesis, reactivity, and olefin polymerization properties of new highly electrophilic zirconium(IV) complexes. Author

**N91-17173#** Marathon Oil Co., Littleton, CO.
**HYDROGEN SULFIDE DECOMPOSITION INTO HYDROGEN AND SULFUR BY QUINONE CYCLES Annual Report No. 1, Jun. 1989 - May 1990**
S. W. Cowley (Colorado School of Mines, Golden.) Jun. 1990 19 p
(Contract GRI-5089-260-1779)
(PB90-270463; GRI-90/0188) Avail: NTIS HC/MF A03 CSCL 07D

The fundamental mechanisms for recovery of sulfur and H2 from H2S, using mild condition cycles based on oxidation of H2S by quinones is evaluated. During this first year, the research focused on the reaction of H2S with tertiary butyl anthraquinone to form tertiary butyl anthrahydroquinone. The progress achieved included extending the quinone conversion from 60 to 80 percent to complete conversion, significantly increasing the rate of conversion by varying the solvent, and developing a proposed mechanism for this part of the process. GRA

**N91-17174#** National Inst. of Standards and Technology, Gaithersburg, MD. Center for Fire Research.
**A MODEL FOR PREDICTING THE GENERATION RATE AND DISTRIBUTION OF PRODUCTS OF COMBUSTION IN TWO-LAYER FIRE ENVIRONMENTS**
Leonar Y. Cooper Sep. 1990 53 p
(PB91-107151; NISTIR-4403) Avail: NTIS HC/MF A04 CSCL 21B

A general model is developed for predicting the generation rates of oxygen, fuel, and any other products of combustion of

interest in rooms containing fires. The model is called the generalized global equivalence ratio model. It extends the steady state global equivalence ratio model established from steady state data of several previous experimental studies. After presenting the details, a concise algorithm is outlined for implementing the model in two layer zone type compartment fire model computer codes. With the algorithm in place, such codes could be used to simulate the distribution of products of combustion in single or multiroom fire environment, including that of steady state, in some of the above mentioned experimental studies. For arbitrary experimental conditions and under the assumption of stoichiometric combustion, solutions for concentrations of products of combustion, are obtained and presented. In one concise result, the solutions are used to predict the time-to-extinguishment of a burning methane fuel source embedded in an initially ambient-atmosphere upper layer. Author

**N91-17175#** Acurex Corp., Mountain View, CA. Environmental Systems Div.

**COMBUSTION EXPERIMENTATION HANDBOOK Final Report, Aug. 1986 - Aug. 1988**

Clement I. Okoh and Richard A. Brown 31 Aug. 1988 425 p
(Contract GRI-5086-234-1323)
(PB91-101923; GRI-88/0143) Avail: NTIS HC/MF A18 CSCL 21B

The handbook covers test planning, diagnostic methods, data analysis techniques, and report writing. The handbook begins with sections on test planning issues including work plans, test plans, variable identification, sensitivity analysis, quality assurance, and figures of merit. This is followed by a discussion of diagnostic techniques including temperature, pressure, flow measurement, flow visualization, and emissions monitoring. The handbook also addresses data gathering and reduction techniques. Gathering of transient data is addressed, as is error analysis and data manipulation. Definitions of key variables and figures of merit that can be used to evaluate systems and experimental data are also provided. Author

**N91-17176#** Michigan Univ., Ann Arbor. Dept. of Aerospace Engineering.

**FLAME STABILITY AND CHARACTERIZATION OF SWIRL-STABILIZED FLAMES, PHASE 1 Final Report, 1 Jan. 1987 - 31 Dec. 1989**

James F. Driscoll and Werner J. A. Dahm 3 Mar. 1990 71 p
(Contract GRI-5087-260-1443)
(PB91-101931; GRI-90/0115-PHASE-1) Avail: NTIS HC/MF A04 CSCL 21B

Experiments were conducted in non-reacting jets and jet flames with and without coaxial air and swirl. To quantify the molecular mixing leading to NO(x) formations, a unique imaging system was developed that visualizes the diffusion layers and quantifies the degree of molecular mixing within them. Three dimensional time-resolved images of the molecular mixing were obtained. To relate these types of local measurements to overall, global flame properties, total NO(x) emission index was measured while varying the degree of coaxial air, Reynolds number, strain rate, fuel type, and in some cases, swirl number. Flame blowout limits were measured for jets with coaxial air and for swirl flames. Theoretical analysis was applied to correlate and explain the flame blowout and liftoff results. GRA

**N91-17177#** National Telecommunications and Information Administration, Annapolis, MD.

**NTIA MICROCOMPUTER SPECTRUM ANALYSIS MODELS (MSAM) MANUAL**

Aug. 1990 235 p
(PB91-100669; NTIA/SW/DK-91/001A) Avail: NTIS HC/MF A11 CSCL 07D

The Microcomputer Spectrum Analysis Models (MSAM) are a collection of engineering programs useful for radio frequency spectrum management. The MSAM models were developed for use by Federal government organizations. These organizations have found the programs to be useful for the solution of spectrum management related problems. NTIA, however, does not guarantee the accuracy of the results. The manual assumes that the reader has an engineering background, and some familiarity with an IBM PC or compatible computer. The manual includes hardware, software, and data requirements as well as installation and operating instructions. Author

**N91-17178#** Cornell Univ., Ithaca, NY. Dept. of Chemistry.

**A COMPARATIVE STUDY OF THE CHEMISORPTION OF ETHYLENE ON THREE METAL SURFACES: Ni(111), Pd(111) AND Pt(111)**

Yat-Ting Wong and Roald Hoffmann 12 Oct. 1990 54 p
Submitted for publication
(Contract N00014-89-J-1052)
(AD-A228534; TR-51) Avail: NTIS HC/MF A04 CSCL 07/4

The chemisorption of ethylene on three metal surfaces, Nickel (111), Paladium (111) and Platinum (111), has been studied by an approximate molecular orbital method: extended Huckel calculations within a tight-binding formalism. The overlap population between individual fragment molecular orbital (FMO) of the adsorbate and each atomic orbital (AO) or atom of the surface can be projected out accurately. The relative importance of each FMO to the ethylene-metal bonding can then be assessed. Moreover, interaction diagrams can be constructed to describe the adsorbate-surface bonding. The preferred adsorption sites determined by our calculations are supported by the vibrational data obtained by electron energy loss scattering. The activation energy for the transformation of a pi-bonded ethylene to a di-sigma-bonded adsorbate on Platinum (111) has been estimated. GRA

**N91-17179#** Yale Univ., New Haven, CT.

**IMPROVEMENT OF GAS ANALYSIS BY ENRICHMENT OF TRACE SPECIES Final Report, 21 Sep. 1987 - 30 May 1990**

John B. Fenn and Juan FernandezdelaMora 30 Sep. 1990 10 p
(Contract DAAL03-87-K-0098)
(AD-A228609; ARO-25014.8-EG) Avail: NTIS HC/MF A02 CSCL 14/2

The objective was to develop a continuous on-line method for enhancing the sensitivity of detection and analysis of trace components in gases. The approach was to increase the concentration of trace species in the sample flow reaching the analyzer and/or detector. Three methods were explored: (1) Inertial Enrichment in the shock layer of stagnation sampling probe on the axis of a supersonic free jet of sample gas. (2) Focusing Enrichment in which microdroplets, aerosol particles or heavy molecules comprising or containing analyte species were aerodynamically focused on the centerline of a subsonic free jet at the entrance to a sampling probe. (3) Electrospray Enrichment in which trace species were scavenged by the highly charged small droplets produced by electrospraying an appropriate liquid, then desorbed as ions for analysis by mass spectrometry. GRA

**N91-17180#** National Inst. of Health, Bethesda, MD.

**IMPROVED APPARATUS FOR COUNTERCURRENT CHROMATOGRAPHY SEPARATIONS AND STABLE METHODS FOR MONITORING THE EFFLUENT THEREOF Patent Application**

O. Hisao, inventor (to NIH) 13 Dec. 1989 32 p
(PB90-141060; US-PATENT-APPL-SN-450111) Avail: NTIS HC/MF A03 CSCL 07D

This patent application relates to a countercurrent chromatography apparatus and to a method of monitoring its effluent. More particularly, the invention provides an improvement to known countercurrent chromatography apparatus technology which substantially avoids the development of turbidity in the flow cell as well as the production of bubbles which interfere with the production of substantially noiseless tracings and improved separation of chemicals. GRA

**N91-17181#** National Inst. of Health, Bethesda, MD.
**SEPARATION OF RARE EARTH ELEMENTS WITH HIGH-SPEED COUNTERCURRENT CHROMATOGRAPHY Patent Application**
Eiichi Kitazome, inventor (to NIH), Yoichiro Ito, inventor (to NIH), and Stephen Ficca, inventor (to NIH) 28 Feb. 1990 27 p
(PB90-243700; US-PATENT-APPL-SN-485317) Avail: NTIS HC/MF A03 CSCL 07D

The six objectives of the invention presented in this patent application are to provide a method for: (1) high speed countercurrent chromatography separation of inorganic compounds; (2) high speed countercurrent chromatography separation of inorganic elements; (3) separating rare earth elements and compounds; (4) detecting rare elements and compounds in mixtures; (5) high speed countercurrent chromatography separation of rare earth elements and compounds; (6) continuous monitoring of high speed countercurrent chromotography; (7) analyzing rare earth elements and compounds in a mixture by rotational high speed countercurrent chromatography and continuously detection for eluted rare earth elements and compounds. GRA

**N91-17182#** California Inst. of Tech., Pasadena. Graduate Aeronautical Labs.
**COMBUSTION IN TURBULENT JETS AND BUOYANT FLAMES, PHASE 1 Final Report, 1 Jan. 1987 - 31 Dec. 1989**
Paul E. Dimotakis, James E. Broadwell, and Edward E. Zukoski 15 May 1990 83 p
(Contract GRI-5087-260-1467)
(PB90-269655; GRI-90/0154) Avail: NTIS HC/MF A05 CSCL 21B

During this research, fundamental studies were conducted to study and document salient features of the phenomenology of turbulent mixing, to the extent necessary to understand the fundamental processes and incorporate the results in simple models. The work focussed on turbulent jet diffusion (non-premixed) flames, extending from the momentum dominated regime to the buoyancy dominated regime, in both reacting and non-reacting flows, in liquids as well as gases. Author

**N91-17183#** Chicago Univ., IL.
**PROGRAMS IN MATERIALS RESEARCH Annual Report**
Sidney R. Nagel Feb. 1990 173 p Submitted for publication
(AD-A228724) Avail: NTIS HC/MF A08 CSCL 15/6

Materials research in the Chicago MRL involves close collaborations between theorists and experimentalists from different disciplines and emphasizes the following areas. THRUST I: SURFACE DYNAMICS: Adparticle Dynamics and Surface Reactivity, Surface Phonon Spectroscopy and Gas Surface Interactions, Seed Area: Structure and Dynamics of Complex Molecular Films. THRUST II: DISORDERED MATERIALS: Lower Dimensional Disorder: Mesoscopic and Layered Materials, Glassiness and Glassy Dynamics, Order-Disorder and Structure. THRUST III: DYNAMICAL PATTERNS AND SOLIDIFICATION: Dynamical Patterns, Dynamics of Solidification, Seed Area: Convective Turbulence. GRA

**N91-17184#** Virginia Univ., Charlottesville. Dept. of Chemical Engineering.
**THEORETICAL AND EXPERIMENTAL STUDY OF MIXED SOLVENT ELECTROLYTES**
P. T. Cummings and J. P. OConnell 1990 11 p
(Contract DE-FG05-88ER-13943)
(DE91-005720; DOE/ER-13943/2) Avail: NTIS HC/MF A03

In the original proposal to study mixed solvent electrolyte solutions, four major goals were formulated: (1) fundamental modeling of mixed solvent electrolytes using numerically solved integral equation approximation theories; (2) evaluation of intermolecular pair potential models by computer simulation of selected systems for comparison with experiment and the numerical integral equation studies; (3) development of fundamentally based correlations for the thermodynamic properties of mixed solvent electrolyte solutions using analytically solvable statistical mechanical models; (4) and extension of the experimental database on mixed solvent electrolytes by performing vapor-liquid equilibrium measurements on selected systems. This paper discusses the progress on these goals. DOE

**N91-17185#** Bureau of Mines, Amarillo, TX. Helium Field Operations.
**IMPROVED METHOD FOR PREPARING GRAVIMETRIC STANDARD GAS MIXTURES OF HELIUM-4 IN NITROGEN**
Nabil A. Bibawy and David E. Emerson 1990 14 p
(PB91-105700; BUMINES-RI-9312) Avail: NTIS HC/MF A03 CSCL 07D

An improved method for preparing gravimetric standard gas mixtures of helium-4 in nitrogen was developed. A single pan 12 kg analytical balance that has a sensitivity of 3 mg is used to prepare the mixture. The balance will accommodate a cylinder having a volume of approx. 4 L that weighs approx. 5 kg. The method was improved to a precision of + or - 0.04 pct by performing four successive dilutions, improved handling of gases in the manifold, and using an improved analytical method to select high purity gases. Author

**N91-17186** Pennsylvania State Univ., University Park.
**A THEORETICAL STUDY OF AUGMENTATION OF PARTICLE COMBUSTION VIA ACOUSTIC ENHANCEMENT OF HEAT AND MASS TRANSFER Ph.D. Thesis**
Man Yeong Ha 1990 291 p
Avail: Univ. Microfilms Order No. DA9032283

Numerical solutions of mass, momentum, energy, and species transport equations in the gas phase for heat and mass transfer and combustion around a spherical particle give the velocity, temperature, and species fields as well as the particle temperature and diameter variation as a function of time. For the case of heat and mass transfer without chemical reaction, the values of axial pressure gradient, shear stress, flow separation and Nusselt number depend on the combined effects of curvature and flow acceleration. The space- and time-averaged Nusselt numbers have different values for frequencies of 50, 1000, and 2000 Hz. The combustion time with and without particle entrainment is almost the same at 1000 Hz but the particle combustion with particle entrainment at 50 Hz takes slightly longer than that without entrainment. The combustion of pulverized coal and coal-water slurry fuels with diameters between 80 to 120 microns exposed to acoustic fields with sound pressure levels of 160 to 170 dB in a typical combustor are investigated theoretically. The acoustically induced slip velocity augments Nusselt and Sherwood numbers, compared to the case with no sound conditions. The main effect of acoustic field is observed during the char combustion phase in a diffusionally controlled situation. A decrease in the char burnout length of about 19.2 and 18 percent at 165 dB for 100 microns pulverized coal particle and coal-water slurry droplets introduced at the centerline, compared to the cases with no sound. A qualitative investigation of high intensity acoustic fields on the combustion of micronized coal is carried out using a flat flame burner. The flame becomes broader at about 2000 Hz, compared to the flame with no sound. The average values of the emitted light intensity about 145 to 150 dB sound pressure levels are 2.5 to 3.5 times higher than those obtained with no sound.
Dissert. Abstr.

**N91-17187** Pennsylvania State Univ., University Park.
**THE ALTERATION OF TURBULENT JET FLAME STRUCTURE A ND COMBUSTION BY AXISYMMETRIC JET PULSING Ph.D. Thesis**
Jeffery Allan Lovett 1990 240 p
Avail: Univ. Microfilms Order No. DA9032331

Flow structure plays an important role in the mixing and chemical reaction processes of turbulent jet diffusion flames. Enhancement or control of jet flame structure may allow for control of the combustion traits of such flames. An experimental study was conducted to study the effects of strong axisymmetric pulsing on a free, vertical, turbulent, propane, jet diffusion flame having an exit over a frequency range of 2 to 1300 Hz with pulse amplitudes ranging from 13 to 89 percent of the centerline exit velocity. The

results show that axisymmetric forcing of the fuel jet produces significant alterations in the structure of a turbulent jet diffusion flame. The effects are frequency dependent and require large pulse amplitudes. Pulsing produces a local interaction with the jet flame structure that is described by a preferred mode coupling which scales with the local large scale jet variables. Forcing with a low frequency near 10 Hz produces an isolated large scale region of combustion and volumetric expansion which widens the jet flame and couples with the buoyancy in the flame far downstream. Post flame emission measurements show that the overall production of NO(x) is not significantly affected by pulsing. Dissert. Abstr.

**N91-17188#** Purdue Univ., West Lafayette, IN. School of Mechanical Engineering.
**ASYNCHRONOUS OPTICAL SAMPLING FOR LASER-BASED COMBUSTION DIAGNOSTICS IN HIGH-PRESSURE FLAMES**
**Progress Report, 15 Dec. 1988 - 14 Dec. 1989**
Galen B. King, Normand M. Laurendeau, and Fred E. Lytle 15 Jan. 1990 16 p
(Grant AF-AFOSR-0051-89; AF Proj. 2308)
(AD-A229045; AFOSR-90-1141TR) Avail: NTIS HC/MF A03 CSCL 21/2

This report describes the progress on the development of a new laser based combustion diagnostic for the quantitative measurement of both major and minor species in high pressure flames. The technique, Asynchronous Optical Sampling (ASOPS), is a state of the art improvement in picosecond pump/probe spectroscopy. Final results from the study of atomic sodium in an atmospheric flame are presented. The first ever UV pump/UV probe ASOPS signal for atomic indium is shown. Techniques for noise reduction are discussed along with initial results. GRA

**N91-17189#** Massachusetts Inst. of Tech., Cambridge. Dept. of Mechanical Engineering.
**VORTEX SIMULATION OF TURBULENT COMBUSTION Annual Technical Progress Report No. 1, Aug. 1989 - Sep. 1990**
Ahmed F. Ghoniem 1 Oct. 1990 10 p
(Grant AF-AFOSR-0491-89; AF Proj. 2308)
(AD-A229079; AFOSR-90-1115TR) Avail: NTIS HC/MF A02 CSCL 20/4

This activity focused on the effect of density variation due to temperature/molecular weight difference and/or heat release in a reacting shear layer in two and three dimensional configurations. In the spatially growing 2D layer, results confirm mixing asymmetry due to density difference between the two streams. A light fast stream has a destabilization effect on the early stages of development; it promotes early roll-up; induces stronger winding inside the eddies, and initiates the pairing at earlier stages. However, the overall spatial growth rate of the layer increases as the density ratio becomes higher; bigger eddies are formed and pairing is completed faster. In 3D simulations, density difference continues to impart a convection velocity on the structures in the direction of heavy stream. That influences the evolution of the streamwise mixing modes and spanwise preferential entrainment is observed. The 3D reacting shear layer simulations confirmed earlier 2D observations that although the reaction zone structure depends on the Damkohler number, product distribution is independent of the kinetic parameters and exhibit strong resemblance to the vorticity field. GRA

**N91-17190#** Minnesota Univ., Minneapolis. Corrosion Research Center.
**OCM AND IMPEDANCE ANALYSIS OF POLYPYRROLE**
**Technical Report, 1 Jan. 1989 - 1 May 1990**
Mary M. Lien, Heai-Ku Park, and W. H. Smyrl 1 May 1990 4 p
(Contract N00014-88-K-0360)
(AD-A229185; TR-29-ONR) Avail: NTIS HC/MF A01 CSCL 07/6

Quartz crystal microbalance studies were used to identify anion insertion or cation insertion in polypyrrole films. In the conditions where only a single species is inserted, impedance measurements were used to characterize the processes of charge injection and diffusion in the films. Impedance behavior of electroactive polymer films display three distinct regions, characterized by different relaxation times. At high frequencies, the simultaneous injection of holes (during oxidation of the polymer) and counterion movement (to maintain charge neutrality) is the rate controlling process. At intermediate frequencies, diffusion of holes and ions in the film is rate limiting. At the lowest frequencies, the finite thickness of the film causes the impedance to become purely capacitive (redox capacity region). GRA

**N91-17191*#** Oak Ridge National Lab., TN.
**OPTICAL CONSTANTS OF SOLID METHANE**
Bishun N. Khare, W. R. Thompson, C. Sagan, E. T. Arakawa, C. Bruel, J. P. Judish, R. K. Khanna, and J. B. Pollack (National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.) 1989 13 p Presented at the 1st International Conference on Laboratory Research for Planetary Atmospheres, Bowie, MD, 25 Oct. 1989
(Contract NGR-33-010-220; NGR-33-010-082; NAGw-637; DE-AC05-84OR-21400)
(NASA-CR-187969; NAS 1.26:187969; DE91-004531; CONF-8910341-1) Avail: NTIS HC/MF A03 CSCL 07D

Methane is the most abundant simple organic molecule in the outer solar system bodies. In addition to being a gaseous constituent of the atmospheres of the Jovian planets and Titan, it is present in the solid form as a constituent of icy surfaces such as those of Triton and Pluto, and as cloud condensate in the atmospheres of Titan, Uranus, and Neptune. It is expected in the liquid form as a constituent of the ocean of Titan. Cometary ices also contain solid methane. The optical constants for both solid and liquid phases of CH4 for a wide temperature range are needed for radiative transfer calculations, for studies of reflection from surfaces, and for modeling of emission in the far infrared and microwave regions. The astronomically important visual to near infrared measurements of solid methane optical constants are conspicuously absent from the literature. Preliminary results are presented of the optical constants of solid methane for the 0.4 to 2.6 micron region. K is reported for both the amorphous and the crystalline (annealed) states. Using the previously measured values of the real part of the refractive index, n, of liquid methane at 110 K n is computed for solid methane using the Lorentz-Lorentz relationship. Work is in progress to extend the measurements of optical constants n and k for liquid and solid to both shorter and longer wavelengths, eventually providing a complete optical constants database for condensed CH4. DOE

**N91-17192#** Texas Technological Univ., Lubbock. Dept. of Chemistry and Biochemistry.
**NOVEL APPROACHES TO IONIC CHROMATOGRAPHY**
**Progress Report, Jan. - Nov. 1990**
Purnendu K. Dasgupta Nov. 1990 4 p
(Contract DE-FG05-84ER-13281)
(DE91-006261; DOE/ER-13281/6) Avail: NTIS HC/MF A01

Research during this reporting period, continued on ionic chromatography. Major progress was made towards on-line on-demand generation of ultrapure chemicals by electrochemical means. The concentration of the generated material is governed electrochemically. DOE

**N91-17193#** Sandia National Labs., Albuquerque, NM. Solar Thermal Collector Technology Div.
**PHOTOCATALYTIC DESTRUCTION OF CHLORINATED SOLVENTS WITH SOLAR ENERGY**
James Pacheco, Mike Prairie, and Larry Yellowhorse 1990 17 p Presented at the 13th ASME-JSME International Solar Energy Conference, Reno, NV, 17-22 Mar. 1991
(Contracts DE-AC04-76DP-00789; SNL-90-1743)
(DE91-000767; SAND-90-1743C; CONF-910318-2) Avail: NTIS HC/MF A03

Sandia National Laboratories and the Solar Energy Research Institute are developing a photocatalytic process to destroy organic contaminants in water. Tests with common water pollutants are being conducted at Sandia's Solar Thermal Test Facility using a

near commercial-scale single-axis tracking parabolic trough system with glass pipe mounted at its focus. Experiments at this scale provide verification of laboratory studies and allow examination of design and operation issues at a real-life scale. The catalyst, titanium dioxide, TiO2, is a harmless material found in paint, cosmetics and toothpaste. Experiments were conducted to determine the effect of key process parameters on destruction rates of two chlorinated organic compounds which are common water pollutants: trichloroethylene and trichloroethane. In this paper, we summarize the engineering-scale results of these experiments and analyses. DOE

# 26 METALLIC MATERIALS

Includes physical, chemical, and mechanical properties of metals, e.g., corrosion; and metallurgy.

**N91-17194#** IIT Research Inst., Chicago, IL.
**CORROSION OF MATERIALS IN MOLTEN CARBONATE FUEL CELLS (MCFC) Final Report**
Edward J. Vesely, Jr. Mar. 1990 75 p
(Contract DE-AC21-86MC-23265)
(DE90-000484; DOE/MC-23265/2822) Avail: NTIS HC/MF A04

Results on corrosion behavior of a number of heat exchanger materials which were exposed to simulated fuel cell environments are given. Effect of alloy composition, exposure time and temperature, type of environments, and effect of carbonate tile on the overall corrosion resistance of materials are discussed. Materials that show promise for separator plants have been identified from exposure tests of up to 5000 h. One of the most significant modes of corrosion, i.e., breakaway corrosion, for a number of materials has been identified. In this mode of corrosion, alloys show tendency of accelerated corrosion after satisfactory performance for several thousands of hours. In such cases, longer term tests are generally undertaken e.g., 5000 h tests have been performed in this contract. IITRI is, however, advocating longer term tests, preferably for 10,000 h which should identify the tendency of alloys to go into breakaway corrosion if those are susceptable to such damage. A total of 24 tests were completed in both oxidizing and fuel gas environments on iron base and nickel base alloys. Twelve-dual atmospheric tests were also conducted by IITRI subcontractor IGT, located in an adjacent building on IIT campus. A detailed analysis of the results which probed into corrosion mechanisms is also given. Finally, effect of exposure in both oxidizing and reducing environment on the mechanical properties of 30A and 314L is also presented in this report. DOE

**N91-17195#** Auburn Univ., AL. Dept. of Materials Engineering.
**THE PROPERTIES AND WELDABILITY OF LOW ACTIVATION FERRITIC STEELS Annual Report**
Bryan A. Chin 11 May 1990 117 p
(Contract DE-FG05-86ER-52139)
(DE90-011872; DOE/ER-52139/90-1) Avail: NTIS HC/MF A06

A series of ferritic steels patterned on the chromium-molybdenum alloys, 2 1/4Cr-1Mo, 9Cr-1MoVNb and 12Cr-1MoVW, were tested for weldability. These steels are being developed as candidates for the first wall and blanket structures of fusion reactors. Use of these materials will minimize the long term radioactive hazards associated with disposal after service. In these low activation alloys, elements which become activated during irradiation with long half lives (Mo and Nb) are replaced. The major changes include the replacement of molybdenum with tungsten, the addition of vanadium in 2 1/4 percent Cr steels, and the replacement of niobium in the 9 percent Cr steel with tantalum. These replacement elements radically modify both the mechanical properties and weldability of the alloys. In this study, the effect of the alloy modifications on the microstructure and the mechanical properties of the welds are presented. Bainitic steels (2 1/4 Cr percent) usually exhibit good weldability, while the martensitic steels (5, 9 and 12 Cr percent) are suspectable to embrittlement in the heat affected zone (HAZ). The objective of this study was to characterize the welded microstructure and mechanical properties of these low activation alloys. Autogeneous bead-on-plate welds were produced using the gas tungsten arc welding (GTAW) process. Microstructure, microhardness, weld bend and tensile test results are reported for the base metal, heat affected zone and fusion zone of the weld. DOE

**N91-17196#** Florida Atlantic Univ., Boca Raton. Dept. of Physics.
**THEORETICAL STUDIES OF METALLIC ALLOYS**
1990 5 p
(Contracts DE-FG05-89ER-45392; MDA972-88-J-1006)
(DE90-011894; DOE/ER-45392/1) Avail: NTIS HC/MF A01

A new method to predict and understand the short-range order in solid-solution alloys from a knowledge only of the atomic numbers of the constituent atoms is discussed. The coherent potential approximation will be used to obtain the electronic contribution to the energy and the Monte Carlo method of statistical mechanics will be used for the thermodynamic part of the calculation. An improved coherent potential approximation will be developed by combining the standard approach with the quadratic KKR band theory method. This will make it easier to predict the properties first principles. DOE

**N91-17197#** Pacific Northwest Lab., Richland, WA.
**MICROSTRUCTURAL EXAMINATION IN FFTF IRRADIATED MANGANESE STABILIZED MARTENSITIC STEEL**
Y. Kohno, A. Kohyama (Tokyo Univ., Japan ), and D. S. Gelles May 1990 9 p Presented at the 4th International Conference on Fusion Reactor Materials, Kyoto, Japan, 4-8 Dec. 1989
(Contract DE-AC06-76RL-01830)
(DE90-011930; PNL-SA-17084; CONF-891204-36) Avail: NTIS HC/MF A02

Transmission electron microscopy has been performed on FFTF irradiated specimens of manganese stabilized martensitic steels in order to identify the cause of irradiation-induced embrittlement. Examinations demonstrated the presence of Fe-Cr-Mn chi phase, a body-centered cubic intermetallic phase, known to be detrimental to mechanical properties. DOE

**N91-17198#** Lockheed Missiles and Space Co., Palo Alto, CA. Research and Development Div.
**FORMULATION OF A PRODUCT CONTAINING THE MULTIFUNCTIONAL CORROSION INHIBITOR SYSTEM DNBM Final Report, Jan. 1985 - Dec. 1989**
L. J. Bailin 22 Dec. 1989 67 p
(Contract N62269-85-C-0218)
(AD-A227524; LMSC-F386100; NADC-90049-60) Avail: NTIS HC/MF A04 CSCL 11/6

Four quaternary ammonium salt inhibitors - DNBM (dichromate, nitrite, borate, and molybdate) - based on the quaternary ammonium chloride phase-change catalyst Adogen 464 were synthesized by double displacement reactions in the laboratory. The DNBM product in kilogram quantities was prepared from the equivalent methylsulfate salt to minimize chloride in the final mixture. The mixture was microencapsulated by means of emulsifying the salts in aqueous methylcellulose, followed by spray drying to remove the water phase. To render the microcapsule shells impermeable to solvents in the epoxy-polyamide test primer formulation during cure, an organosilane was applied by vapor deposition. Fumed silica was added after spray drying and before silanizing to change the form of the microcapsules from flocculated to free-flowing. The microcapsules were in the 5 to 50 micron particle size range, with some 100 micron particles observed. The basic capsules contained up to 78 percent DNBM core (payload). The inhibitor, DNBM, was developed to retard corrosion fatigue and stress corrosion cracking in high-strength steels and aluminum alloys. General corrosion test results were highly favorable with regard to the absence of lifting and rusting of epoxy-coated steel panels or near the test scribles, in comparison with control coatings. GRA

**N91-17199#** Air Force Systems Command, Wright-Patterson AFB, OH. Foreign Technology Div.

**THE FABRICATION AND CHARACTERISTICS OF Ta2N FIELD EMITTERS**

Xiang-Qi Jiang and Takeo Kato 20 Sep. 1990 22 p Transl. into ENGLISH from Dianzi Xuebao (Peoples Republic of China), v. 13, no. 3, May 1985 p 50-55

(AD-A227556; FTD-ID(RS)T-0576-90) Avail: NTIS HC/MF A03

The electron beam emission elements used in micro-manufacturing are made more and more important with the rapid advancement of electronic ocmponents and devices. Furthermore, the development of scanning electron microscopes Furthermore, the development of scanning electron microscopes with high resolution also promote the study of high intensity electron beam sources. At present, the mechanism of field emission of tungsten has been studied extensively and the results have been applied to many practical situations. However, the work function of tungsten is relatively high and due to the adsorption and decomposition of residual gas atoms and molecules on the surface, the diffusion of these adsorbed atoms and molecules, and the impact on the surface of the cathode from the positive ions produced by the ionization of the gas molecules, the emission current was in general very unstable. In order to keep the current stable, it is necessary to operate the emitter under a vacuum of ten to the minus 9th power torr or better. This is the reason why the tungsten field emitter cathode has not been used extensively. Therefore, the investigation of a new electron beam source with properties better than tungsten is important. GRA

**N91-17200#** Wichita State Univ., KS. National Inst. for Aviation Research.

**STUDY OF PRECIPITATION AND DEFORMATION CHARACTERISTICS OF THE ALUMINUM-LITHIUM ALLOY BY X RAY DOUBLE CRYSTAL DIFFRACTOMETRY**

J. Chaudhuri, V. Gondhalekar, A. Inchekel, and J. E. Talia Aug. 1990 18 p Previously announced in IAA as A90-52632

(Grant DAAL03-87-G-0003)

(NIAR-90-25) Avail: NTIS HC/MF A03

The x ray double crystal diffractometry technique was utilized to follow the aging and deformation characteristics in the aluminum-lithium (Al-Li) alloy. This nondestructive method is extremely sensitive to measure the strain and dislocation density within individual grains through x ray rocking curves. For aging at 200 C, optimum aging needed for maximum hardness was 32 h. Dislocation multiplication was responsible for reduction of hardness beyond 32 h aging. In addition, when the specimen was deformed in tension, both compressive and tensile residual strains were found within individual grains. Author

**N91-17201#** North Carolina State Univ., Raleigh. Dept. of Materials Science and Engineering.

**EFFECTS OF ELECTRIC FIELDS AND CURRENTS ON MICROSTRUCTURE, PROPERTIES, AND PROCESSING OF METALS AND ALLOYS**

Hans Conrad and Arnold F. Sprecher 1 Jul. 1990 19 p

(Contracts DAAL03-89-K-0115; DAAL03-86-K-0015)

(AD-A228647; ARO-26825.12-MS) Avail: NTIS HC/MF A03

CSCL 11/6

A summary is presented of the results obtained on the effects of electric fields and currents on the properties and processing of metals and alloys. These results confirm that an electric field or current can have a significant direct influence on the microstructure and properties of metals and alloys, in addition to the indirect effects of Joule heating or induced mechanical stresses. The resulting effects thus need to be taken into account when considering the use of metals and alloys (structural or electronic) in environments containing such field or currents. Moreover, the effects can be beneficial in the working, forming and processing of metals and alloys, offering opportunities regarding: (1) difficult to fabricate materials; (2) more efficient processes; (3) manipulation of microstructure; and (4) improved properties of the product.

GRA

**N91-17202#** National Inst. of Standards and Technology, Gaithersburg, MD. Center for Computing and Applied Mathematics.

**EFFECT OF GRAVITY MODULATION ON SOLUTAL CONVECTION DURING DIRECTIONAL SOLIDIFICATION**

B. T. Murray, S. R. Coriell, and G. B. McFadden Aug. 1990 31 p

(PB90-265281; NISTIR-90/4389) Avail: NTIS HC/MF A03

CSCL 11F

During directional solidification of a binary alloy at constant velocity, thermosolutal convection may occur due to the temperature and solute gradients associated with the solidification process. For vertical growth in an ideal furnace (lacking horizontal gradients), a quiescent state is possible. For a range of processing conditions, the thermal Rayleigh number is sufficiently small that the stabilizing role of the thermal field during growth vertically upwards may be neglected, and only solutal convection need be considered. The effect of a time-periodic vertical gravitational acceleration (or equivalently vibration) on the onset of solutal convection is calculated based on linear stability using Floquet theory. It was found that a stable base state can be destabilized due to modulation, while an unstable state can be stabilized. The flow and solute disturbance fields show both synchronous and subharmonic temporal response to the driving sinusoidal modulation. GRA

**N91-17203#** Michigan Univ., Ann Arbor. Dept. of Nuclear Engineering.

**THE ROLE OF GRAIN BOUNDARY CHEMISTRY AND STRUCTURE IN THE ENVIRONMENTALLY-ASSISTED INTERGRANULAR CRACKING OF NICKEL-BASE ALLOYS**

**Progress Report**

Gary S. Was 1990 24 p

(Contract DE-FG02-85ER-45184)

(DE91-004588; DOE/ER-45184/8) Avail: NTIS HC/MF A03

An experimental research program is proposed with the objective of determining the role of the chemistry and structure of grain boundaries in the environmentally-assisted intergranular cracking (EAIC) of nickel-base alloys. Recent work conducted under our current grant has shown that several (previously unreported) microstructural features may control grain boundary cracking. These include the occurrence of IG cracking in carbon-depleted Ni-16Cr-9Fe (alloy 600) and carbon-free Ni-30Cr-9Fe (alloy 690), the formation of strong grain boundary orientation textures following thermal mechanical processing, and the dependence of oxide film composition on C and Cr content. The proposed program focuses on: (1) the role of carbon in solution and as carbides on the IG creep-controlled cracking in 360 C water; (2) determination of the role of grain boundary orientation on IG cracking in 360 C water and creep in 360 C Ar; and (3) the role of the film character (composition and structure) in the correlation of creep, repassivation rate, and IGSCC susceptibility in Ni-(16-30)Cr-Fe alloys. Experiments will be conducted on laboratory and commercial heats of Ni-16Cr-9Fe (alloy 600), Ni-30Cr-9Fe (alloy 690) and to a limited extent, alloy X-750 (Ni-16Cr-9Fe-Al-Ti-Nb). The program is designed to systematically isolate each of the aforementioned features, and to determine their influence on IG cracking in high temperature water with the objective of controlling IG cracking through the control of grain boundary chemistry and structure. DOE

**N91-17204#** Pacific Northwest Lab., Richland, WA.

**MECHANICAL PROPERTY CHANGES AND MICROSTRUCTURES OF DISPERSION-STRENGTHENED COPPER ALLOYS AFTER NEUTRON IRRADIATION AT 411, 414, AND 529 C**

K. R. Anderson, J. F. Stubbins (Illinois Univ., Urbana.), F. A. Garner, and M. L. Hamilton Jun. 1990 44 p Presented at the 15th International Symposium on Effects of Radiation on Materials, Nashville, TN, 17-21 Jun. 1990

(Contract DE-AC06-76RL-01830)

(DE91-005518; PNL-SA-17555; CONF-900623-23) Avail: NTIS HC/MF A03

Dispersion strengthened copper alloys have shown promise

for certain high heat flux applications in both near term and long term fusion devices. This study examines mechanical properties changes and microstructural evolution in several oxide dispersion strengthened alloys which were subjected to high levels of irradiation-induced displacement damage. Irradiations were carried out in FFTF to 34 and 50 dpa at 411 to 414 C and 32 dpa at 529 C. The alloys include several oxide dispersion-strengthened alloys based on the Cu-Al system, as well as ones based on the Cu-Cr and Cu-Hf systems. Of this group, certain of the Cu-Al alloys, those produced by an internal oxidation technique to contain alumina weight fractions of 0.15 to 0.25 percent outperformed the other alloys in all respects. These alloys, designated CuAl15, CuAl20, and CuAl25, were found to be resistant to void swelling up to 50 dpa at 414 C, and to retain their superior mechanical and physical properties after extended irradiation. The major factor which controls the stability during irradiation was found to be the dispersoid volume fraction and distribution. The other alloys examined were less resistant to radiation-induced properties changes for a variety of reasons. Some of these include dispersoid redistribution by ballistic resolution, effects of retained dissolved oxygen, and non-uniformity of dispersion distribution. The effect of laser welding was also examined. This joining technique was found to be unacceptable since it destroys the dispersoid distribution and thereby the resistance of the alloys to radiation-induced damage. DOE

**N91-17205#** Los Alamos National Lab., NM. Center for Materials Science.

**MICROSTRUCTURAL EVOLUTION OF Fe GROWN ON A (001) Cu FILM AND ITS IMPLICATION TO THE ELASTIC ANOMALY IN METALLIC SUPERLATTICES**

J. Koike and M. Nastasi 1990 7 p Presented at the Fall Meeting of the Materials Research Society, Boston, MA, 26 Nov. - 1 Dec. 1990 Submitted for publication

(Contract W-7405-eng-36)

(DE91-005875; LA-UR-90-4266; CONF-901105-51) Avail: NTIS HC/MF A02

A large softening of the shear modulus has been reported in metallic superlattices composed of insoluble bcc/fcc metals. In an attempt to understand this elastic anomaly, we have studied the microstructure of Fe/Cu bilayers as a function of the Fe thickness with transmission electron microscopy (TEM). Analysis of the moire fringes observed in plan-view TEM images revealed that the fcc Fe structure epitaxially grows on the (001) Cu up to a thickness of 2.0 nm. At 2.3 nm, the bcc Fe structure nucleates, accompanying lattice rotation around the growth direction with respect to the underlying fcc structure. As the Fe thickness further increases, the submicron polycrystalline grains formed. Based on these results, the microstructure of the metallic superlattices and its relation to the softening of the shear modulus will be discussed. DOE

**N91-17206#** Bureau of Mines, Rolla, MO.

**ELECTROCHEMICAL IMPEDANCE SPECTROSCOPY STUDY OF CORROSION OF PAINTED COLD-ROLLED AND ELECTROGALVANIZED SHEET STEEL FOR AUTOMOTIVE USE Report of Investigations, 1990**

Marion Dattilo, R. B. Prater, and V. R. Miller 1990 19 p

(PB91-110718; BUMINES-RI-9324; LC-90-2095) Avail: NTIS HC/MF A03 CSCL 11F

The use of waste-derived zinc as a partial replacement for pure zinc in the electrogalvanizing process was investigated. The end product of this process is automotive sheet, which has enhanced cosmetic protection over previously used cold-rolled (CR) steel. Primer-coated specimen of CR and electrogalvanized (EG) steel were subjected to the on-vehicle environment and periodically monitored by electrochemical impedance spectroscopy (EIS) during immersion in 1 M NaCl solution. The results of these tests were compared to immersion-only conditions. Scanning electron microscope and energy dispersive x ray techniques were also used to evaluate the corrosion processes and compare them to atmospheric exposure specimen. EIS was found to measure the corrosion associated with on-vehicle exposure, thus providing an excellent screening technique for evaluation of the performance of EG automotive sheet steel. Y.S.

**N91-17207#** National Inst. of Standards and Technology, Gaithersburg, MD. Materials Science and Engineering Lab.

**EFFECT OF OXYGEN TRANSPORT AND RESISTIVITY OF THE ENVIRONMENT ON THE CORROSION OF STEEL Final Report**

E. Escalante, T. Oka (Nippon Steel Corp., Tokyo, Japan ), and U. Bertocci Sep. 1990 39 p Sponsored by Nuclear Regulatory Commission, Washington, DC

(PB91-107292; NISTIR-90/4266) Avail: NTIS HC/MF A03 CSCL 11F

The rate of corrosion and its spatial distribution are investigated, that develop under conditions where transport of oxygen and conductivity of the environment are controlled over a wide range (including low conductivity as expected in the Yucca Mountain environment). The results indicate that the corrosion rate of steel is directly related to the rate of oxygen transport over several orders of magnitude, and increasing conductivity by one order of magnitude increases corrosion rate by a factor of three. Of greater significance is the result that indicates that as conductivity of the environment decreases, and corrosion rate decreases, the degree of localized attack increases. Author

**N91-17208*#** National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.

**ELECTROCHEMICAL STUDIES OF CORROSION INHIBITORS**

M. D. Danford Washington Nov. 1990 21 p

(NASA-TP-3066; NAS 1.60:3066) Avail: NTIS HC/MF A03 CSCL 11F

The effect of single salts, as well as multicomponent mixtures, on corrosion inhibition was studied for type 1010 steel; for 5052, 1100, and 2219-T87 aluminum alloys; and for copper. Molybdate-containing inhibitors exhibit an immediate, positive effect for steel corrosion, but an incubation period may be required for aluminum before the effect of a given inhibitor can be determined. The absence of oxygen was found to provide a positive effect (smaller corrosion rate) for steel and copper, but a negative effect for aluminum. This is attributed to the two possible mechanisms by which aluminum can oxidize. Corrosion inhibition is generally similar for oxygen-rich and oxygen-free environments. The results show that the electrochemical method is an effective means of screening inhibitors for the corrosion of single metals, with caution to be exercised in the case of aluminum. Author

**N91-17209*#** Virginia Univ., Charlottesville. Dept. of Materials Science.

**NASA-UVa LIGHT AEROSPACE ALLOY AND STRUCTURES TECHNOLOGY PROGRAM Progress Report, 1 Jul. - 31 Dec. 1990**

Richard P. Gangloff, John K. Haviland, Carl T. Herakovich, Walter D. Pilkey, Marek-Jerzy Pindera, John R. Scully, Glenn E. Stoner, Robert E. Swanson (Virginia Polytechnic Inst. and State Univ., Blacksburg.), Earl A. Thornton, and Franklin E. Wawner, Jr. et al 30 Jan. 1991 134 p

(Grant NAG1-745)

(NASA-CR-187895; NAS 1.26:187895; UVA/528266/MS91/107) Avail: NTIS HC/MF A07 CSCL 11F

The general objective of the NASA-UVa Light Aerospace Alloy and Structures Technology Program was to conduct research on the performance of next generation, light weight aerospace alloys, composites, and associated thermal gradient structures. The following research areas were actively investigated: (1) mechanical and environmental degradation mechanisms in advanced light metals and composites; (2) aerospace materials science; (3) mechanics of materials and composites for aerospace structures; and (4) thermal gradient structures. Y.S.

**N91-17210#** Maryland Univ., College Park. Dept. of Chemical and Nuclear Engineering.
**FUNDAMENTAL STUDIES ON HIGH TEMPERATURE DEFORMATION, RECRYSTALLIZATION, AND GRAIN GROWTH OF TWO-PHASE MATERIALS Final Technical Report, 1 Sep. 1985 - 30 Nov. 1989**
S. Ankem, G. Grewal, and M. N. Vijayshankar 26 Sep. 1990 87 p
(Grant AF-AFOSR-0367-85; AF Proj. 2306)
(AD-A229017; AFOSR-90-1079TR) Avail: NTIS HC/MF A05 CSCL 11/6

Two-phase materials are technologically important because optimum properties can be obtained by proper combinations of phases. Among these materials, two-phase titanium alloys are of particular interest for high temperature aerospace applications. In order to design new alloys or to optimize the properties of existing titanium alloys, it is essential to understand the deformation behavior and microstructure evolution of alpha, alpha-beta, and beta titanium alloys. This understanding is the subject of the investigation. The effect of strength difference between phases on deformation behavior of two-phase materials is determined by the finite element method. It was found that the observed flow stress drops followed by steady state behavior in beta titanium alloys strongly depend on pre-strain, prior heat treatments, and the amount and nature of alloying elements. The flow stress drops were attributed to the multiplication of mobile dislocations and the steady state behavior was attributed to the dynamic recovery leading to the formation of subgrains. GRA

**N91-17211#** National Inst. of Standards and Technology, Boulder, CO.
**ALUMINUM ALLOYS FOR CRYOGENIC TANKS: OXYGEN COMPATIBILITY, VOLUME 1 Interim Report, Nov. 1988 - Jun. 1990**
Richard Palmer Reed, Nancy Jane Simon, Joseph David McColskey, John Roland Berger, Christopher Nelson McCowan, James Warren Bransford, and Elizabeth Susan Drexler Sep. 1990 207 p Sponsored by Air Force Astronautics Lab., Edwards AFB, CA
(AD-A229229; NISTIR-3942-VOL-1; AL-TR-90-063-VOL-1) Avail: NTIS HC/MF A10 CSCL 11/6

In Part 1 of this program, Al-Li alloys 8090-T3 and 2090-T81 and Al alloy 2219 (tempers T851, T37) were tested for compatibility with liquid oxygen using pressurized mechanical-impact apparatuses at two NASA laboratories, Marshall Space Flight Center (MSFC) and White Sands Test Facility (WSTF). Specimens and data from tests at Santa Susana Field Laboratory (SSFL), Rocketdyne, on alloy 2090-T81 were supplied by ALCOA. Pressurized mechanical-impact data on alloy WL049-T351 were produced by WSTF. In addition, WSTF conducted open-cup mechanical-impact and promoted-combustion tests on all alloys. Reactions occurred in some specimens of all alloys during pressurized mechanical-impact tests at MSFC. There were no reactions during similar tests at WSTF and SSFL. The reactions at MSFC are not attributed to specimen contamination. This interim report analyzes the ignitions found in the MSFG pressurized mechanical-impact tests, compares the results and test methodologies of both MSFC and WSTF facilities (since each laboratory is producing test data that are apparently divergent), and addresses the current test standard document NASA NHB 8060.1B as it pertains to this study. GRA

**N91-17212#** National Inst. of Standards and Technology, Boulder, CO.
**REVIEW OF CRYOGENIC MECHANICAL AND THERMAL PROPERTIES OF Al-Li ALLOYS AND ALLOY 2219 Final Report, Nov. 1988 - Jun. 1990**
Nancy Jane Simon, Elizabeth Susan Drexler, and Richard Palmer Reed Sep. 1990 197 p Sponsored by Air Force Astronautics Lab., Edwards AFB, CA
(AD-A229231; AL-TR-90-064) Avail: NTIS HC/MF A09 CSCL 11/6

The review of cryogenic mechanical and thermal properties presented here is part of a broader NIST program to assess new high-strength Al-Li alloys for use in the cryogenic tankage of the Advanced Launch System. This program is sponsored by the Air Force Systems Command, Astronautics Laboratory, Edwards Air Force Base. with Bao Nguyen, Task Manager. It is part of the Materials and Process Validation (3101) of the Structures, Materials, and Manufacturing (3000) portion of the ALS Advanced Development Program. Since the purpose of the NIST program has been to assess the relative suitability of high-strength Al-Li alloys and alloy 2219 for use in ALS cryogenic tanks, data on Al-Li alloys 8090, 2090, Weldalite 049, and Al alloy 2219 have been included in the survey. Properties covered in this survey are tensile strength, yield strength, elongation, fracture toughness, elastic constants, specific heat, thermal conductivity, and thermal expansion. GRA

**N91-17213#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Systems and Logistics.
**MICROCLIMATES AND CORROSION: A MATHEMATICAL MODEL OF CORROSION FOR GANDO AFB, SPAIN M.S. Thesis**
Francisco J. Almagro-Gonzales Sep. 1990 75 p
(AD-A229242; AFIT/GLM/LSM/90S-1) Avail: NTIS HC/MF A04 CSCL 11/6

The purpose was to determine whether the degree of corrosion to be encountered at one specific location, due to the local weather conditions could be predicted by a mathematical model. The corrosion data used were gathered by Spanish National Institute of Aerospace Technology at Gando AFB, Canary Island, Spain. Only two variables, wind and distance to the sea shore of every location, were included in the model because they were found to be the only two varying from one place to another. In doing so, one formula was devised using regression analysis that was statistically proved to be useful to predict the general corrosion index to be found at every place within a certain range at Gando AFB, Spain. GRA

**N91-17214#** SRI International Corp., Menlo Park, CA.
**EVALUATION OF A DIFFUSION/TRAPPING MODEL FOR HYDROGEN INGRESS IN HIGH-STRENGTH ALLOYS Final Technical Report, Nov. 1988 - Nov. 1990**
Bruce G. Pound 14 Nov. 1990 95 p
(Contract N00014-86-C-0233; SRI Proj. PYU-1962)
(AD-A229288) Avail: NTIS HC/MF A05 CSCL 11/6

The objective of this research was to obtain the hydrogen ingress and trapping characteristics for a range of microstructures and so identify the dominant type of irreversible trap in different alloys. A diffusion/trapping model was used in conjunction with a potentiostatic pulse technique to study the ingress of hydrogen in three precipitation-hardened alloys (Inconel 718, Incoloy 925, and 18Ni maraging steel), two work-hardened alloys (Inconel 625 and Hastelloy C-276), titanium (pure and grade 2), and copper-enriched AISI 4340 steel in 1 mol/L acetic acid-1 mol/L sodium acetate containing 15 ppm arsenic oxide. In all cases except pure titanium, the data were shown to fit the interface-control form of the model and values were determined for the irreversible trapping constants (k) and the flux of hydrogen into the alloys. The density of irreversible trap defects were calculated from k and generally found to be in close agreement with the concentration of a specific heterogeneity in each alloy. Moreover, the trapping constants for the alloys were found to be consistent with their relative susceptibilities to hydrogen embrittlement. GRA

**N91-17215#** Westinghouse Savannah River Co., Aiken, SC.
**A METALLURGICAL EVALUATION OF STRESS CORROSION CRACKING IN LARGE DIAMETER STAINLESS STEEL PIPING**
D. A. Wheeler, D. E. Rawl, Jr., and M. R. Louthan, Jr. 1990 14 p Presented at the 23d International Metallographic Society Annual Convention, Cincinnati, OH, 23-25 Jul. 1990
(Contract DE-AC09-89SR-18035)
(DE91-005658; WSRC-MS-90-151; CONF-9007133-4) Avail: NTIS HC/MF A03

Ultrasonic testing (UT) of the stainless steel piping in the primary

coolant water system of SRS reactors indicates the presence of short, partly-through-wall stress corrosion cracks in the heat-affected zone of approximately 7 percent of the circumferential pipe welds. These cracks are thought to develop by intergranular nucleation and mixed mode propagation. Metallographic evaluations have confirmed the UT indications of crack size and provided evidence that crack growth involved the accumulation of chloride inside the growing crack. It is postulated that the development of an oxygen depletion cell inside the crack results in the migration of chloride ions to the crack tip to balance the accumulation of positively charged metallic ions. The results of this metallurgical evaluation, combined with structural assessments of system integrity, support the existence of leak-before-break conditions in the SRS reactor piping system. DOE

**N91-17216#** Argonne National Lab., IL. Materials Science Div.
**ATOMISTIC SIMULATION OF RADIATION-INDUCED AMORPHIZATION OF THE B2 ORDERED INTERMETALLIC COMPOUND NiTi**
Michael J. Sabochick (Air Force Inst. of Tech., Wright-Patterson AFB, OH.) and Nghi Q. Lam Dec. 1990 7 p Presented at the Fall Meeting of the Materials Research Society, Boston, MA, 26-30 Nov. 1990 Sponsored by AFIT
(Contract W-31-109-eng-38)
(DE91-006032; CONF-901105-58) Avail: NTIS HC/MF A02

Amorphization of the B2 intermetallic compound NiTi under electron irradiation has been investigated using molecular dynamics. The effect of irradiation was simulated using two processes: (1) Ni and Ti atoms were exchanged, resulting in chemical disorder; and (2) Frenkel pairs were introduced, leading to the formation of stable point defects and also chemical disorder upon mutual recombination of interstitials and vacancies. After approximately 0.4 exchanges per atom, the first process resulted in an energy increase of approximately 0.11 eV/atom and a volume increase of 1.91 percent. On the other hand, after introducing approximately 0.5 Frenkel pairs per atom, the second process led to smaller increases of 0.092 eV/atom in energy and 1.43 percent in volume. The calculated radial distribution functions (RDFs) were essentially identical to each other and to the calculated RDF of a quenched liquid. The structure factor; however, showed that long-range order was still present after atom exchanges, while the introduction of Frenkel pairs resulted in the loss of long-range order. It was concluded that point defects are necessary for amorphization to occur in NiTi, although chemical disorder alone is capable of storing enough energy to make the transition possible. DOE

**N91-17217#** Argonne National Lab., IL.
**ION BEAM MODIFICATIONS OF NEAR-SURFACE COMPOSITIONS IN TERNARY ALLOYS**
Nghi Q. Lam, S. Tang, A. M. Yacout, L. E. Rehn, and J. F. Stubbins (Illinois Univ., Urbana.) Nov. 1990 12 p Presented at the 7th International Conference on Ion Beam Modification of Materials, Knoxville, TN, 9-14 Sep. 1990 Revised
(Contract W-31-109-eng-38)
(DE91-006035; CONF-900936-25) Avail: NTIS HC/MF A03

Changes in the surface and subsurface compositions of ternary alloys during elevated-temperature sputtering with inert-gas ions were investigated. Theoretically, a comprehensive kinetic model which includes all the basic processes, such as preferential sputtering, displacement mixing, Gibbsian segregation, radiation-enhanced diffusion and radiation-induced segregation, was developed. This phenomenological approach enables one to predict the effects of each individual process or of a combination of processes on the compositional modification in model alloys. Experimentally, measurements of compositional changes at the surface of a Ag-40 at percent Au to 20 at percent Cu alloy during 3-keV Ne(sup +) bombardment at various temperatures were made, using ion scattering spectroscopy. These measurements were interpreted on the basis of the results of theoretical modeling. DOE

**N91-17218#** Idaho National Engineering Lab., Idaho Falls.
**MICROSTRUCTURE AND MECHANICAL PROPERTIES OF P/M (POWDER METALLURGY) Fe3Al ALLOYS**
J. R. Knibloe, R. N. Wright, and V. K. Sikka (Oak Ridge National Lab., TN.) 1990 13 p Presented at the Conference on Powder Metallurgy, Pittsburgh, PA, 20-23 May 1990
(Contracts DE-AC07-76ID-01570; DE-AC05-84OR-21400)
(DE91-006132; EGG-M-90118; CONF-900547-1) Avail: NTIS HC/MF A03

Alloys based on Fe3Al have an equilibrium DO sub 3 structure at low temperatures and transform to a B2 structure above about 550 C. The influence of different rates of quenching from the B2 region to room temperature on the microstructure and mechanical properties of powder metallurgy (P/M) alloys with two different Cr contents has been examined. By optimizing the processing to maximize the amount of B2 order, room temperature ductility approaching 20 percent has been achieved, although the fracture mode is primarily brittle cleavage. The refined microstructure resulting from P/M processing contributes to enhanced yield strength compared to ingot processed materials with similar ductility. Increasing the Cr content from 2 to 5 percent has little effect on mechanical properties. DOE

**N91-17219#** Oak Ridge National Lab., TN.
**THE HARDNESS AND ELASTIC MODULUS OF TIN FILMS AS DETERMINED BY ULTRA-LOW LOAD INDENTATION**
M. E. OHern, W. C. Oliver, C. J. McHargue, D. S. Rickerby, and S. J. Bull (United Kingdom Atomic Energy Authority, Harwell, England ) 1990 5 p Presented at the Spring Meeting of the Materials Research Society, San Francisco, CA, 16-21 Apr. 1990
(Contract DE-AC05-84OR-21400)
(DE91-006336; CONF-900466-98) Avail: NTIS HC/MF A01

The mechanical properties of a series of titanium nitride films on stainless steel substrates were evaluated using an indentation technique with a mechanical properties microprobe (MPM). The MPM makes possible measurement of film properties without contribution by the substrate material. The titanium nitride films were deposited with a PVD technique known as sputter ion plating (SIP). Deposition substrate bias was varied from 0 to -120 V, while keeping other deposition parameters constant. With increasing negative substrate bias, dramatic increases in hardness and elastic modulus were observed. DOE

**N91-17220#** California Univ., Berkeley. Lawrence Berkeley Lab. Center for Advanced Materials.
**A MICROSTRUCTURAL STUDY OF CREEP AND THERMAL FATIGUE DEFORMATION IN 60Sn-40Pb SOLDER JOINTS Ph.D. Thesis**
Dana Tribula 2 Jun. 1990 78 p Prepared in cooperation with California Univ., Berkeley
(Contract DE-AC03-76SF-00098)
(DE91-005404; LBL-29018) Avail: NTIS HC/MF A05

Thermal fatigue failures of solder joints in electronic devices often arise from cyclic shear strains imposed by the mismatched thermal expansion coefficients of the materials that bind the joint as temperature changes are encountered. Increased solder joint reliability demands a fundamental understanding of the metallurgical mechanisms that control the fatigue to design accurate accelerated probative tests and new, more fatigue resistant solder alloys. The high temperatures and slow strain rates that pertain to thermal fatigue imply that creep is an important deformation mode in the thermal fatigue cycle. In this work, the creep behavior of a solder joint is studied to determine the solder's microstructural response to this type of deformation and to relate this to the more complex problem of thermal fatigue. It is shown that creep failures arise from the inherent inhomogeneity and instability of the solder microstructure and suggest that small compositional changes of the binary near-eutectic Pn-Sn alloy may defeat the observed failure mechanisms. This work presents creep and thermal fatigue data for several near-eutectic Pb-Sn solder compositions and concludes that a 58Sn-40Pb-2In and a 58Sn-40Pb-2Cd alloy show significantly enhanced fatigue resistance over that of the simple binary material. DOE

**N91-17221#** Oak Ridge National Lab., TN. Metals and Ceramics Div.
**THE ROLE OF TWINNING IN BRITTLE FRACTURE OF TI-ALUMINIDES**
M. H. Yoo, C. L. Fu, and J. K. Lee (Michigan Technological Univ., Houghton.) 1990 10 p Presented at the Fall Meeting of the Materials Research Society, Boston, MA, 24 Nov. - 1 Dec. 1990 Revised
(Contract DE-AC05-84OR-21400)
(DE91-005506; CONF-901105-48) Avail: NTIS HC/MF A02

The important roles of twinning in cleavage fracture of single phase (gamma)-TiAl and TiAl3 are assessed on the basis of theoretically calculated elastic constants, shear fault energies, and cleavage energies. The importance of elastic anisotropy in both homogeneous twin nucleation theory and dislocation models for twin nucleation is emphasized. The twin-slip conjugate relationship makes an important contribution to the strain compatibility for localized plasticity at crack-tip of Mode-I type. The intrinsic brittleness of these aluminides is attributed to a combined effect of the low mobility of slip and twin dislocations and the relatively low cleavage strength. The effect of the resolved normal stress on the twin plane is to enhance twinning activity at a crack-tip, leading to transformation toughening of shear type. DOE

**N91-17222#** Oak Ridge National Lab., TN. Metals and Ceramics Div.
**MICROSTRUCTURE AND MECHANICAL PROPERTIES OF NI3AL-BASED ALLOYS REINFORCED WITH PARTICULATES**
C. G. McKamey and C. A. Carmichael 1990 7 p Presented at the Fall Meeting of the Materials Research Society, Boston, MA, 24 Nov. - 1 Dec. 1990
(Contract DE-AC05-84OR-21400)
(DE91-005515; CONF-901105-45) Avail: NTIS HC/MF A02

Hot-extrusion was used to produce Ni3Al-based alloys to which 10 vol percent TiN, NbC, HfO2, or HfN was added for reinforcement. The TiN, NbC, and HfO2 particulates produced Ni3Al-matrix composites in which no reaction was noted at the particle-matrix interface. However, the addition of HfN resulted in extensive reaction in which the hafnium appeared to diffuse into the matrix. Microstructures of this alloy showed a complex array of phases and voids where the HfN particles are presumed to have been originally. Hot hardness, compression, and compression creep tests were preformed on specimens cut from the extruded bar of each alloy. No significant strengthening was observed for the alloys containing TiN, NbC, or HfO2. However the HfN-containing alloy did show significant strengthening in simple compression and compression creep. This presentation will include microstructures and the results of the mechanical properties tests. DOE

**N91-17223#** Argonne National Lab., IL. Materials Science Div.
**METALLIC SUPERLATTICES: STRUCTURAL AND ELASTIC PROPERTIES**
M. Grimsditch and Ivan K. Schuller (California Univ., San Diego, La Jolla.) 1990 11 p Presented at the 6th Latin-American Symposium on Surface Physics, Cusco, Peru, 3-7 Sep. 1990 Submitted for publication
(Contracts W-31-109-eng-38; N00014-88-K-0210)
(DE91-006037; CONF-9009323-1; REPT-58918-00-105) Avail: NTIS HC/MF A03

The fabrication and structural characterization of metallic superlattices is discussed. Methods to determine the elastic properties of these materials (which can only be prepared as thin films) are reviewed and the results obtained using various techniques are summarized. Contrary to theoretical expectation, the elastic properties are found to depend on the modulation wavelength. DOE

**N91-17224#** Oak Ridge National Lab., TN. Metals and Ceramics Div.
**FIRST-PRINCIPLES INVESTIGATION OF MECHANICAL BEHAVIOR OF B2 TYPE ALUMINIDES: FeAl AND NiAl**
C. L. Fu and M. H. Yoo 1990 7 p Presented at the Fall Meeting of the Materials Research Society, Boston, MA, 24 Nov. - 1 Dec. 1990
(Contract DE-AC05-84OR-21400)
(DE91-006284; CONF-901105-63) Avail: NTIS HC/MF A02

First-principles calculations of the elastic constants, shear fault energies, and cleavage strength of NiAl and FeAl are presented. For NiAl, we find that the dissociation of (111) superdislocation into partial dislocations is unlikely, due to a high antiphase boundary energy and a weak repulsive elastic force between partial dislocations. FeAl has a high ideal cleavage strength as a result of the directional d-bond formation at the Fe sites. The strong ordering behavior of NiAl is explained in terms of the Al-to-Ni charge transfer and the repulsive interaction between Al atoms. The spontaneous glide decomposition of the (111) superdislocation in NiAl is also discussed. DOE

**N91-17225#** Argonne National Lab., IL. Materials and Components Technology Div.
**STRESS CORROSION CRACKING OF CANDIDATE STRUCTURAL MATERIALS UNDER SIMULATED FIRST-WALL/AQUEOUS COOLANT ENVIRONMENTS**
M. R. Fox, A. B. Hull, and T. F. Kassner Oct. 1990 31 p Presented at the 9th Topical Meeting on Technology of Fusion Energy, Oak Brook, IL, 7-11 Oct. 1990 Submitted for publication
(Contract W-31-109-eng-38)
(DE91-006370; CONF-901007-45) Avail: NTIS HC/MF A03

Stress corrosion cracking (SCC) susceptibility of Types 316NG, 316, and 304 stainless steels (SS) was investigated in slow-strain-rate tests (SSRTs) in oxygenated water that simulates important parameters anticipated in first-wall/blanket systems. The water chemistry was based on a computer code which yielded the nominal concentrations of radiolytic species produced in an aqueous environment under ITER-type conditions. Actual SSRTs were performed in a less benign, more oxidizing reference environment at temperatures from 52 to 150 C. Predominantly ductile fracture was observed in Type 316NG and nonsensitized Types 316 SS and 304 SS SSRT specimens strained to failure in a reference ITER water chemistry. The failure behavior of Type 304 SS specimens heat-treated to yield sensitization values of 2, 3, or 20 Coulomb (C)/cm(sup 2) by the electrochemical potentiokinetic reactivation (EPR) technique, demonstrated that the degree of sensitization had a dramatic effect on intergranular stress corrosion cracking (IGSCC) susceptibility. Ranking for resistance to SCC in simulated ITER water by electron microscopy and SSRT parameters, i.e., failure time, ultimate strength, total elongation and stress ratio is 304 SS (EPR = 20 less than 2 C/cm(sup 2)) less than 316NG SS. DOE

**N91-17226#** Westinghouse Savannah River Co., Aiken, SC. Nuclear Reactor Technology and Scientific Computations Div.
**MOLECULAR MODELING OF METAL HYDRIDES. 2: CALCULATION OF LATTICE DEFECT STRUCTURES AND ENERGIES UTILIZING THE EMBEDDED ATOM METHOD**
R. J. Wolf and K. A. Mansour Dec. 1990 21 p
(Contract DE-AC09-89SR-18035)
(DE91-006436; WSRC-TR-90-275) Avail: NTIS HC/MF A03

Lattice defect structures and energies for palladium, nickel and aluminum computed include: single vacancy, self-interstitial, intrinsic stacking fault, coherent twin boundary and (100), (110), and (111) free surfaces. The importance of considering lattice defects in obtaining an accurate Embedded Atom Method (EAM) description of real materials, and the application of the EAM to the computation of lattice defect structures for palladium, nickel and aluminium is discussed. The EAM functions developed in this study reproduce defect properties well and are suitable for future investigations of metal hydrides involving defect related structures. DOE

**N91-17227#** Argonne National Lab., IL.
**MICROSTRUCTURAL EVOLUTION IN A FERRITIC-MARTENSITIC STAINLESS STEEL AND ITS RELATION TO HIGH-TEMPERATURE DEFORMATION AND RUPTURE MODELS**
R. J. DiMelfi, E. E. Gruber, and J. M. Kramer 1991 19 p Presented at the Annual Meeting and Exhibition of the Minerals,

Metals and Materials Society, New Orleans, LA, 17-21 Feb. 1991
(Contract W-31-109-eng-38)
(DE91-006471; CONF-910202-2) Avail: NTIS HC/MF A03

The ferritic-martensitic stainless steel HT-9 exhibits an anomalously high creep strength in comparison to its high temperature flow strength from tensile tests performed at moderate rates. A constitutive relation describing its high temperature tensile behavior over a wide range of conditions has been developed. When applied to creep conditions the model predicts deformation rates orders of magnitude higher than observed. To account for the observed creep strength, a fine distribution of precipitates is postulated to evolve over time during creep. The precipitate density is calculated at each temperature and stress to give the observed creep rate. The apparent precipitation kinetics thereby extracted from this analysis is used in a model for the rupture time kinetics that compares favorably with observation. Properly austenitized and tempered material was aged over times comparable to creep conditions, and in a way consistent with the precipitation kinetics from the model. Microstructural observations support the postulates and results of the model system. DOE

**N91-17228#** Argonne National Lab., IL.
**SWELLING AND TENSILE PROPERTIES OF NEUTRON-IRRADIATED VANADIUM ALLOYS**
B. A. Loomis and D. L. Smith Jul. 1990 15 p Presented at the Conference on the Effect of Irradiation on Materials of Fusion Reactors, Leningrad (USSR), 18-20 Sep. 1990
(Contract W-31-109-eng-38)
(DE91-006588; CONF-9009264-4) Avail: NTIS HC/MF A03

Vanadium-base alloys are candidates for use as structural material in magnetic fusion reactors. In comparison to other candidate structural materials (e.g., Type 316 stainless and HT-9 ferritic steels), vanadium-base alloys such as V-15Cr-5Ti and V-20Ti have intrinsically lower long term neutron activation, neutron irradiation after-heat, biological hazard potential, and neutron induced helium and hydrogen transmutation rates. Moreover, vanadium-base alloys can withstand a higher surface heat, flux than steels because of their lower thermal stress factor. In addition to having these favorable neutronic and physical properties, a candidate alloy for use as structural material in a fusion reactor must have dimensional stability, i.e., swelling resistance, and resistance to embrittlement during the reactor lifetime at a level of structural strength commensurate with the reactor operating temperature and structural loads. Experimental results are presented on the swelling and tensile properties of several vanadium-base alloys after irradiation at 420, 520, and 600 C to neutron fluences ranging from 0.3 to 1.9 x 10(exp 27) neutrons/sq m (17 to 114 atom displacements per atom (DPA)). DOE

# 27 NONMETALLIC MATERIALS

Includes physical, chemical, and mechanical properties of plastics, elastomers, lubricants, polymers, textiles, adhesives, and ceramic materials.

For composite materials see *24 Composite Materials*.

**N91-17229#** Allied-Signal Aerospace Co., Kansas City, MO. Technical Communications Div.
**EVALUATION OF FILLED ELASTOMERS Final Report**
B. Wilder May 1990 17 p
(Contract DE-AC04-76DP-00613)
(DE90-010338; KCP-613-4255) Avail: NTIS HC/MF A03

A one-piece, molded-to-size, filled elastomer part was designed as a process improvement for a three-piece configuration. The molding and bonding processes were evaluated, in addition to characteristics such as density, thickness, particle size distribution, and x ray. DOE

**N91-17230#** Argonne National Lab., IL. Materials Science Div.
**TEMPERATURE DEPENDENCE OF THE FIRST SHARP DIFFRACTION PEAK IN VITREOUS SILICA**
Lori K. Moen, D. G. Montague (Williamette Univ., Salem, OR.), S. Susman, K. J. Volin, and D. L. Price Apr. 1990 5 p Presented at the 4th National Undergraduate Research Conference, Schenectady, NY, 19-21 Apr. 1990
(Contract W-31-109-eng-38)
(DE90-011181; CONF-9004186-2) Avail: NTIS HC/MF A01

Diffraction measurements on glasses often generate a structure factor with a prominent first sharp diffraction peak (FSDP). A temperature dependent change in the FSDP is most often attributed to two competing effects. Reduced frustration arising from a lower density tends to increase the intensity and decrease the width, while thermal vibrations tend to decrease the intensity and increase the width. In covalent glasses, the FSDP typically broadens and decreases in height with increasing temperature. Most oxide and chalcogenide glasses display a reversibly increasing FSDP with increasing temperature. Although vitreous silica (SiO2) has been extensively researched, only Soklakov et al. have investigated its structure factor at elevated temperatures. They concluded that the temperature dependence of the FSDP (observed in x ray diffraction patterns) was comparable to other oxide and chalcogenide glasses. Vitreous SiO2, however, has an extremely small coefficient of thermal expansion (0.55 x 10(exp -6)cm/cm deg C). Consequently its density varies little with temperature and an increase in the intensity of its FSDP is not expected. The purpose of this study is to determine the temperature dependence of the FSDP in vitreous silica using modern methods of neutron scattering. DOE

**N91-17231#** China Nuclear Information Centre, Beijing.
**INVESTIGATION OF METHODS TO PREPARE CARBON FOILS AND TO DETERMINE THEIR THICKNESSES**
Guoji Xu, Shouren Guan, Xinghua Luo, and Xiangjin Meng (Institute of Atomic Energy, Beijing, China ) 1988 7 p In ENGLISH and CHINESE
(DE90-638126; CNIC-00249; IAE-0061) Avail: NTIS (US Sales Only) HC/MF A02

The development and study of methods to prepare carbon foils and to determine their thicknesses are described. The methods of making carbon foils consist of carbon-arc evaporation, resistance heating, electron bombardment, cracking ethylene, and centrifugal precipitation. Weighting, alpha particle measurement, Rutherford backscattering and spectrophotometers are used to determine the thickness of carbon foils. DOE

**N91-17232#** Oak Ridge National Lab., TN. Solid State Div.
**LASER-INDUCED FLUORESCENCE AND NONLINEAR OPTICAL PROPERTIES OF ION-IMPLANTED FUSED SILICA**
Klaus Becker, L. Yang, R. F. Haglund, Jr., R. H. Magruder, R. A. Weeks (Vanderbilt Univ., Nashville, TN.), and R. A. Zuhr 1990 11 p Presented at the 7th International Conference on Ion Beam Modification of Materials, Knoxville, TN, 9-14 Sep. 1990
(Contracts DE-AC05-84OR-21400; N00014-87-C-0146; NSF DMR-85-13731)
(DE91-004523; CONF-900936-23) Avail: NTIS HC/MF A03

We report absorption, fluorescence and nonlinear optical properties of fused silica implanted with Ti, Cu and Bi and doses of 1 x 10(exp 15) ions/cm(sup 2) to 6 x 10(exp 16) ions/cm(sup 2) when irradiated with 532 nm laser light. The fluorescence spectrum is a broad band around 640 nm shows little variation for all ion species. Absorption as function of implanted dose shows a threshold for Ti between 1 x 10(exp 16) ions/cm(sup 2) and 6 x 10(exp 16) ions/cm(sup 2). The nonlinear optical index is large, n(sub 2) greater than 10(exp -5) esu. All measured quantities show a strong dependence on the implanted ion dose. The source of the nonlinearity, whether electronic or thermal, remains to be more completely determined. DOE

**N91-17233#** Wichita State Univ., KS. National Inst. for Aviation Research.
**FINITE SIZE EFFECTS AND FILM MATERIALS**
James Ho, ed. Oct. 1990 15 p Presented at the 1st Materials Research Workshop, Wichita, KS, 15-16 Oct. 1990
(NIAR-90-28) Avail: NTIS HC/MF A03

Abstracts of research on finite size effects and film materials

are given. An introduction to finite size effects, finite size effects and the melting and freezing behavior of small particles, magnetic aspects of fine/ultrafine particles, superconducting thin films, as-deposited Bi(Pb-Sb)-Sr-Ca-Cu-O films, finite size effects and the electrical transport properties of granular metal thin films, x ray diffraction analysis of thin films, and electrophoretic deposition of high-temperature superconductors are among the topics covered. Author

**N91-17234#** Colorado State Univ., Fort Collins. Dept. of Chemistry.
**TEMPLATE-SYNTHESIZED POLYACETYLENE FIBRILS SHOW ENHANCED SUPERMOLECULAR ORDER**
Wenbin Liang and Charles R. Martin 24 Oct. 1990 11 p Submitted for publication Sponsored by AFOSR
(Contract N00014-82-K-0612)
(AD-A228596; TR-55) Avail: NTIS HC/MF A03 CSCL 07/6

A template method for synthesizing nanoscopic conductive polymer fibrils was recently described. In this method, the pores in a nanoporous host membrane are used as templates for the nascent conductive polymer. It was shown that such template-synthesized fibrils show significantly higher conductivities than bulk films of the analogous polymer. It is suggested that this enhanced conductivity results from preferential orientation of the polymer chain parallel to the fibril axis. This paper provides the first experimental proof for such enhanced supermolecular order in template-synthesized conductive polymer fibrils. The template synthesis of nanoscopic polyacetylene fibrils are described (for the first time). It is demonstrated (using a polarized infrared absorption experiment) that the polymer chains in these fibrils are preferentially oriented parallel to the fibril axis. GRA

**N91-17235#** Rockwell International Science Center, Thousand Oaks, CA.
**THE MICROSCOPIC ORIGINS OF TOUGHNESS AND IMPACT RESISTANCE IN METAL-REINFORCED CERAMICS Final Report, 15 Aug. 1988 - 30 Jun. 1990**
Brian N. Cox 28 Jul. 1990 6 p
(Contract DAAL03-88-C-0027)
(AD-A228610; RI/SC5554.FR; ARO-25367.8-MS) Avail: NTIS HC/MF A02 CSCL 11/2

It has been shown that fracture resistance in the metal-reinforced ceramics WC/Co, Al2O3/Al, and B4C/Al arises from both plasticity and crack bridging. The theoretical basis has been laid for interpreting high resolution measurements of displacement fields and crack opening profiles to deduce the proportion of toughening due to each of these mechanisms in detail. Preliminary analysis accounting for plasticity alone has been presented for data for WC/Co. Various theoretical results have been obtained concerning the inverse problem of deducing bulk plastic strain fields from surface displacement measurements and deducing bridging tractions from measured crack opening profiles. GRA

**N91-17236#** Michigan Technological Univ., Houghton.
**FUNDAMENTAL RESEARCH ON POROUS GLASS DESICCANTS Annual Report, May 1989 - Apr. 1990**
Michael E. Mullins and Bahne C. Cornilsen Jun. 1990 75 p Sponsored by Gas Research Inst., Chicago IL
(Contract GRI-5089-260-1780)
(PB90-260530; GRI-90/0162) Avail: NTIS HC/MF A04 CSCL 11C

The main goal is to produce advanced desiccant materials meeting the criteria required for desiccant cooling systems. Desiccant processes for dehumidifying and cooling are promising gas-fired air conditioning options. The formulation of two phase materials, alumino-silicates and boro-silicates, and their processing were studied. Two-step addition of catalyst appears to be the best method to control the final product characteristics. Author

**N91-17237#** Minnesota Univ., Minneapolis. Corrosion Research Center.
**AMBIENT TEMPERATURE SOLID POLYMER ELECTROLYTE DEVICES Technical Report, 1 Jan. 1989 - 1 May 1990**
P. S. S. Prasad, M. Z. Munshi, B. B. Owens, and W. H. Smyri 1 May 1990 2 p
(Contract N00014-88-K-0360)
(AD-A228716; TR-31-ONR) Avail: NTIS HC/MF A01 CSCL 09/1

A variety of new materials for ambient temperature polymer electrolyte batteries are under investigation. These materials include some derivatives of polyether complexes with plasticizer salts. Phase diagrams, x ray diffraction, nuclear magnetic resonance, electro-chemical stability and ion transport studies have been carried out, to fully evaluate these materials. Prototype electrochemical cells based on these polymer electrolytes have been subjected to extended cycling at various temperatures in order to assess the performance efficiencies as well as changes within the cell structure. GRA

**N91-17238#** Rensselaer Polytechnic Inst., Troy, NY.
**NEW NON-LINEAR OPTICAL POLYMERS Final Report, 15 May 1988 - 14 Oct. 1989 Ph.D. Thesis - Massachusetts Inst. of Technology**
Ilya Gorodisher Aug. 1990 144 p
(Contract F49620-88-C-0078)
(AD-A228746; AFOSR-90-1070TR) Avail: NTIS HC/MF A07 CSCL 07/6

New polyurethanes were prepared which exhibit non-linear optical activity. The polymers were poled during synthesis, advantage being taken of the fast polymerization kinetics. Second harmonic generation (SHG) was observed from these polymers. In selected cases, no decrease in the SHF signal (due to depolarization) was observed at room temperature for up to one month. The SHG activity of a series of organic model compounds was also investigated. GRA

**N91-17239#** Pacific Northwest Lab., Richland, WA. Materials and Chemical Sciences Center.
**THEORETICAL DETERMINATION OF THE NONLINEAR OPTICAL PROPERTIES OF INORGANIC POLYMERS**
Steven M. Risser and Kim F. Ferris Mar. 1990 11 p Presented at the 1989 Boulder Damage Symposium, Boulder, CO, 1-3 Nov. 1989 Submitted for publication
(Contract DE-AC06-76RL-01830)
(DE91-005183; PNL-SA-17356; CONF-8911192-8) Avail: NTIS HC/MF A03

Third order hyperpolarizabilities were calculated using the Huckel Hamiltonian and third order perturbation theory for a series of phosphonitrilic compounds, (X2P-N)sub n, as a function of bond length alternation, ligand substitution, and backbone conformation. Phosphonitrilic compounds show hyperpolarizabilities comparable to those reported for organic species and are modulated by ligand group electronegativity. In contrast to organic polyenes, the difference in (pi) orbital energy between phosphorus and nitrogen is critical to determining the onset of saturation and the magnitude of the hyperpolarizability. Conformation effects are smaller than those seen in polyenes. DOE

**N91-17240#** Oak Ridge National Lab., TN.
**THE EVALUATION OF ENVIRONMENTAL EFFECTS IN TOUGHENED CERAMICS FOR ADVANCED HEAT ENGINES INVESTIGATION OF SELECTED SiC AND Si3N4 CERAMICS Final Report, Jan. - Aug. 1987**
N. L. Hecht, G. A. Graves, D. E. McCullum, A. P. Berens, S. Goodrich, J. D. Wolf, J. R. Hoenigman, P. Yaney, D. Grant, and S. Hilton Aug. 1990 91 p Prepared in cooperation with Dayton Univ., OH
(Contract DE-AC05-84OR-21400)
(DE91-005638; ORNL/SUB-84-00221/2) Avail: NTIS HC/MF A05

The primary focus of this project is an investigation of the effects of environment on the mechanical behavior of commercially

available ceramic materials being considered for use in heat engines. Based on results from an earlier study, three materials, two Si3N4 and one SiC, were selected for further characterization and evaluation. Microstructure, chemistry, physical characteristics, and mechanical properties at 25 C and 1450 C were investigated. DOE

**N91-17241#** Argonne National Lab., IL.
**SOLID-PARTICLE EROSION OF ALUMINUM/PARTICULATE CERAMIC COMPOSITES**
K. C. Goretta, W. Wu, J. L. Routbort, and P. K. Rohatgi (Wisconsin Univ., Milwaukee.) Jun. 1990 10 p Presented at the Conference on the Tribology of Composite Materials, Oak Ridge, TN, 1-3 May 1990
(Contract W-31-109-eng-38)
(DE91-006078; CONF-900513-3) Avail: NTIS HC/MF A02

Impact erosion of 2014 aluminum, 2014 aluminum + 20 vol percent particulate silicon carbide, and 2014 aluminum + 20 vol percent particulate aluminum oxide has been studied at room temperature. The alloys were tested in the as-received and heat-treated conditions. Experiments were conducted with aluminum oxide abrasive in vacuum in a slinger-type apparatus over a range of abrasive size, velocity, and angle of impact. Erosion rates were influenced by reinforcement and heat treatment. Reduced ductility, both overall and local, attributed to reinforcement or heat treatment, caused, under most conditions, more rapid erosion of the composites. The data suggest that erosion rate can be minimized by proper microstructural control, involving reducing reinforcement segregation and the amount of intermetallic compounds. DOE

**N91-17242#** Oak Ridge National Lab., TN. High Temperature Materials Lab.
**GRAIN STRUCTURE AND GROWTH OF DISPERSED PHASE BN-AIN COATINGS GROWN VIA CHEMICAL VAPOR DEPOSITION**
Garth B. Freeman, W. J. Lackey, John A. Hanigofsky, Woo Y. Lee (United Technologies Research Center, East Hartford, CT.), and Karren L. More 1990 7 p Presented at the Fall Meeting of the Materials Research Society, Boston, MA, 25-30 Nov. 1990 Submitted for publication
(Contract DE-AC05-84OR-21400)
(DE91-006283; CONF-901105-62) Avail: NTIS HC/MF A02

This paper discusses the variation in microstructures encountered during the separate depositions of boron nitride (BN) and aluminum nitride (AIN) as well as during the codeposition of BN-AIN dispersed phase ceramic coatings. This combination was chosen in order to take advantage of the self lubricating properties of hexagonal BN along with the hard, erosion resistance of AIN. Films were characterized using scanning and transmission electron microscopy (SEM and TEM), x ray photoelectron spectroscopy (XPS), and x ray diffraction (XRD). A range of coating microstructures are possible depending on the conditions of deposition. The best films produced, in terms of hardness, density, and tenacity, were a fine mixture of turbostratic BN and preferentially oriented AIN whiskers aligned with the whisker axis perpendicular to the substrate surface as seen by both electron microscopy and x ray diffraction. DOE

**N91-17243#** Sandia National Labs., Albuquerque, NM.
**QUANTITATIVE INFRARED DETERMINATION OF COMPOSITION AND PROPERTIES OF BOROPHOSPHOSILICATE GLASS (BPSG) THIN FILMS USING MULTIVARIATE CALIBRATION**
J. A. McGuire, I. S. Adhihetty, T. M. Niemczyk (New Mexico Univ., Albuquerque.), D. M. Haaland, D. F. Taylor, D. M. Blankenship, and G. R. Iben 1991 15 p Presented at the 42nd Pittsburgh Conference and Exposition on Analytical Chemistry and Applied Spectroscopy, Chicago, IL, 4-8 Mar. 1991 Sponsored by Semiconductor Research Corp.
(Contract DE-AC04-76DP-00789)
(DE90-017030; SAND-90-2064C; CONF-910311-1) Avail: NTIS HC/MF A03

Partial least squares multivariate calibration methods were applied to the infrared spectra of a new set of borophosphosilicate glass (BPSG) thin films on silicon wafers. The calibration samples were prepared by a low pressure chemical vapor deposition (LPCVD) process. The statistically designed calibration set included data from nearly 400 coated Si wafers. Calibrations were attempted for properties such as dopant concentrations, thickness, etch rate, film stress, and electrical parameters. It was found that annealed films were predicted more precisely than unannealed films. B, P, and thickness measurements yielded the most precise results by these techniques. Multivariate calibration methods applied to etch rate for annealed films and unannealed film stress provided some limited predictive ability. The detection and removal of outliers greatly improved the analysis precisions. Finally, within wafer and between wafer dopant uniformity may be responsible for degrading the precision of these analytical methods. DOE

**N91-17244#** Oak Ridge National Lab., TN. Metals and Ceramics Div.
**CERAMIC TECHNOLOGY FOR ADVANCED HEAT ENGINES PROJECT Semiannual Progress Report, Oct. 1989 - Mar. 1990**
Sep. 1990 507 p
(Contract DE-AC05-84OR-21400)
(DE91-005644; ORNL/TM-11586) Avail: NTIS HC/MF A22

This project was developed to meet the ceramic technology requirements of the OTT's automotive technology programs. Advanced heat engine programs have provided evidence that the operation of ceramic parts in high-temperature engine environments is feasible; however, these programs have also demonstrated that additional research is needed in materials and processing development, design methodology, and data base and life prediction before industry will have a sufficient technology base from which to produce reliable cost-effective ceramic engine components commercially. An assessment of needs was completed, and a five-year plan was developed with extensive input from private industry. The objective of the project is to develop the industrial technology base required for reliable ceramics for application in advanced automotive heat engines. The project approach includes determining the mechanisms controlling reliability, improving processes for fabrication existing ceramics, developing new materials with increased reliability, and testing these materials in simulated engine environments to confirm reliability. Although this is a generic materials project, the focus is on the structural ceramics for advanced gas turbine and diesel engines, ceramic bearings and attachments, and ceramic coatings for thermal barrier and wear applications in these engines. The main topics covered include: monoliithics, ceramic composites, thermal and wear coatings, ceramic-metal joints, modeling, contact interfaces, structural qualification, time-dependent behavior; environmental effects; fracture mechanics; nondestructive evaluation development; and technology transfer. DOE

# 28 PROPELLANTS AND FUELS

Includes rocket propellants, igniters, and oxidizers; their storage and handling procedures; and aircraft fuels.

For related information see also *07 Aircraft Propulsion and Power, 20 Spacecraft Propulsion and Power,* and *44 Energy Production and Conversion.*

**N91-17245#** Sandia National Labs., Albuquerque, NM. Explosive Subsystems Div.
**DEVELOPMENT OF DIODE LASER-IGNITED PYROTECHNIC AND EXPLOSIVE COMPONENTS**
R. G. Jungst, F. J. Salas, R. D. Watkins, and L. Kovacic 1990 20 p Presented at the 15th International Pyrotechnics Seminar, Boulder, CO, 9-13 Jul. 1990
(Contract DE-AC04-76DP-00789)
(DE90-011238; SAND-90-0031C; CONF-900792-6) Avail: NTIS HC/MF A03

Studies are described which have led to the development of prototype diode laser-ignited pyrotechnic and explosive devices.

These are of interest because they eliminate some concerns associated with ignition from hot wires such as conductance after firing, sensitivity to electromagnetic radiation and electrostatic discharge, and bridgewire corrosion. The availability of high power diode lasers is a key feature for the success of this concept. A pyrotechnic, Ti/KClO4, and the deflagration-to-detonation transition (DDT) explosive CP have been evaluated and found suitable for use in LDI components. Doping with materials such as carbon black to increase light absorption near 800 nm is a major factor in reducing the laser power required to ignite CP, but does not strongly affect the ignition of Ti/KClO4. Other material and laser input parameters were also studied to determine their influence on ignition thresholds. Even though they contain different energetic materials, the energy-power relationship of these optical igniters was generally similar in shape to those of other thermal ignition devices such as stable and electric igniters. Prototype, hermetically sealed, optical headers have been fabricated, loaded, and test fired with CP and Ti/KClO4. Glass to metal sealing technology has been developed to insert sapphire windows or optical fiber segments in these fixtures. Devices containing fiber segments demonstrated superior performance in threshold tests. DOE

**N91-17246#** Office of Technology Assessment, Washington, DC.
**REPLACING GASOLINE: ALTERNATIVE FUELS FOR LIGHT-DUTY VEHICLES**
Sep. 1990 146 p
(PB91-104901; OTA-E-364) Avail: NTIS HC/MF A07; also available SOD HC $7.00 as 052-003-01206-5 CSCL 21D

During the past year, the debate on reauthorizing the Clean Air Act caused a resurgence of interest in alternative transportation fuels as an option for reducing ozone levels in urban areas that cannot otherwise meet air quality standards. The possibility of greenhouse climate change has increased interest in those alternative fuels that do not rely on fossil fuel feedstocks or that can otherwise offer a net reduction in greenhouse emissions. The report provides a broad overview of the costs and benefits of introducing methanol, ethanol, natural gas, electricity, hydrogen, and reformulated gasoline into the U.S. light-duty fleet, and additionally provides more detailed analysis of a few particularly contentious issues such as the air quality impacts and costs of methanol use. GRA

**N91-17247#** Manufacturing and Technolgy Conversion International, Inc., Columbia, MD.
**PRODUCTION OF LOW-COST HYDROGEN Quarterly Technical Progress Report No. 3, 2 Apr. 1989 - 24 Jun. 1990**
1990 14 p
(Contract DE-AC21-89MC-26367)
(DE91-005669; DOE/MC-26367/2931; MTCI-26367-107) Avail: NTIS HC/MF A03

The overall objective of the proposed effort is to verify at the laboratory scale, the ability of the MTCI indirectly heated fluid-bed gasifier to economically produce a hydrogen-rich product gas from liquefaction by-product streams and from char produced in mild gasification processes. Specifically, the proposed effort is aimed at developing an experimental technology data base by defining the process characteristics that would be required for process integration into an overall liquefaction system. This would result in substantial decreases in the cost of hydrogen for the production of competitively priced coal-derived liquid fuels. During this quarter, shakedown tests of the reactor were completed. Subbituminous coals from Black Thunder mine and Eagle Butte mine were obtained for use in mild gasification to produce char. During the initial shakedown tests, it was determined that a new pulse combustor was needed. A pulse combustor with a large aerovalve was fabricated and tested. Three shakedown tests with limestone as the fluid-bed medium were carried out at temperature from 1450 to 1550 F. DOE

**N91-17248#** Ballistic Research Labs., Aberdeen Proving Ground, MD.
**EFFECTS OF METAL CONTAMINATION ON HYDROXYLAMMONIUM NITRATE-BASED LIQUID MONOPROPELLANTS Final Report, Jan. - Dec. 1986**
Cris A. Watson, John D. Knapton, Nathan Boyer, and Irvin Stobie Oct. 1990 36 p
(AD-A229177; BRL-MR-3869) Avail: NTIS HC/MF A03 CSCL 19/1

A hydroxylammonium-nitrate-based liquid gun propellant, LGP 1846, was intentionally contaminated with four separate metals and subjected to storage, shock sensitivity, and closed-bomb tests. The metal contaminants used were iron, copper, nickel, and aluminum. The contaminant concentrations for the storage and the sensitivity tests were approximately 25, 75, and 100 ppm. For the closed-bomb tests, a concentration of approximately 100 ppm was used. Results indicated that the contaminated samples were stable for at least two weeks. The addition of the contaminants increased the sensitivity of the LGP 1984 slightly. The closed-bomb results showed that the contaminants decreased the time required to ignite the propellant by hot wire. The closed-bomb tests also showed that the nickel and aluminum contaminants tended to decrease ignition delay times by 22 and 19.5 percent, respectively. The iron and copper samples showed 5.6 and 2.6 percent decreases in ignition delay. Also, the fizz-to-flame transition pressure was found to differ from that found in a previous study. GRA

**N91-17249#** Union Carbide Corp., South Charleston, WV. Chemical and Plastics Div.
**DIRECT CONVERSION OF METHANE TO C2'S AND LIQUID FUELS**
Barbara Knight Warren, Kenneth D. Campbell, J. L. Matherne, and N. E. Kinkade 12 Mar. 1990 234 p
(Contract DE-AC22-87PC-79817)
(DE91-005872; DOE/PC-79817/7) Avail: NTIS HC/MF A11

The objectives of the project are to discover and evaluate novel catalytic systems for the conversion of methane or by-product light hydrocarbon gases either indirectly (through intermediate light gases rich in C2s) or directly to liquid hydrocarbon fuels, and to evaluate, from an engineering perspective, different conceptualized schemes. The approach is to carry out catalyst testing on several specific classes of potential catalysts for the conversion of methane selectively to C2 products. The behavior of alkaline earth/metal oxide/halide catalysts containing strontium was found to be different from the behavior of catalysts containing barium. Two approaches were pursued to avoid the heterogeneous/homogeneous mechanism in order to achieve higher C2 selectivity/methane conversion combinations. One approach was to eliminate or minimize the typical gas phase combustion chemistry and make more of the reaction occur on the surface of the catalyst by using silver. Another approach was to change the gas phase chemistry to depart from the typical combustion reaction network by using vapor-phase catalysts. The layered perovskite K2La2Ti3O10 was further studied. Modifications of process and catalyst variables for LaCaMnCoO6 catalysts resulted in catalysts with superior performance. Results obtained with a literature catalyst Na2CO3/Pr6O11 were better than those obtained with NaCO3/Pr-Ce oxide or Na2CO3/Ag-Pr-Ce oxide. DOE

# 29 MATERIALS PROCESSING

Includes space-based development of products and processes for commercial applications.
For biological materials see *55 Space Biology.*

**N91-17250*#** National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
**DROP DEPLOYMENT SYSTEM FOR CRYSTAL GROWTH APPARATUS Patent Application**
Percy Rhodes, inventor (to NASA), Robert S. Snyder, inventor (to

NASA), and Marc L. Pusey, inventor (to NASA) 18 Dec. 1990 17 p
(NASA-CASE-MFS-28422-1; NAS 1.71:MFS-28422-1; US-PATENT-APPL-SN-629740) Avail: NTIS HC/MF A03 CSCL 22A

A crystal growth apparatus is presented. It utilizes a vapor diffusion method for growing protein crystals, and particularly such an apparatus wherein a ball mixer is used to mix the fluids that form a drop within which crystals are grown. Particular novelty of this invention lies in utilizing a ball mixer to completely mix the precipitate and protein solutions prior to forming the drop. Additional novelty lies in details of construction of the vials, the fluid deployment system, and the fluid storage system of the preferred embodiment. NASA

# 31 ENGINEERING (GENERAL)

Includes vacuum technology; control engineering; display engineering; cryogenics; and fire prevention.

**N91-17251#** Sydney Univ. (Australia). School of Civil and Mining Engineering.
**CONTROL OF WIND-INDUCED TALL BUILDING VIBRATION BY TUNED MASS DAMPERS**
Y. L. Xu, K. C. S. Kwok, and B. Samali (University of Technology, Sydney, Australia ) Apr. 1990 49 p
(PB90-259334; R-617) Avail: NTIS HC/MF A03 CSCL 13B

Wind tunnel model tests and theoretical analyses were conducted to investigate the effectiveness of tuned mass dampers in suppressing wind-induced tall building motion. The tall building model was a 1:400 scale aeroelastic model. The model and the tuned mass damper models of different parameters were designed and tested in a wind tunnel with properly simulated atmospheric boundary layer flow. The aeroelastic test of the model demonstrated the effectiveness of the tuned mass damper system in suppressing the dynamic response of the building. The parametric study of passive tuned mass dampers, leading to theoretical analysis and design of an effective and efficient tuned mass damper system, was based on excitation spectra which were directly measured from the wind tunnel model tests. Theoretical results were in good agreement with the test results. The analytical results further indicated that the effectiveness of tuned mass dampers can be enhanced by the inclusion of an active control system. Author

**N91-17252#** Tecogen, Inc., Waltham, MA.
**DEVELOPMENT OF A GAS ENGINE-DRIVEN CHILLER Annual Report, Jan.-Nov. 1988**
Mike Koplow and John Morgan Oct. 1989 77 p
(Contract GRI-5084-293-1135)
(PB90-270414; TR4474-156-89; GRI-90/0038) Avail: NTIS HC/MF A05 CSCL 13B

The final year of activity in a program to develop a natural gas engine-driven chiller with a nominal capacity of 150 tons is reported. During the overviewed period the field testing of six chillers continued, and the seventh and the final field test chillers was installed and started. Field test hours for the period totalled 17,299, bringing the total field test hours to 24,247. The reliability and serviceability of the chiller proved to be within the bounds of acceptability for this type of equipment. A ton-hour weighted coefficient of performance of 1.26 was obtained. Y.S.

**N91-17253#** Army Cold Regions Research and Engineering Lab., Hanover, NH.
**PREDICTING THE BEHAVIOR OF ASPHALT CONCRETE PAVEMENTS IN SEASONAL FROST AREAS USING NONDESTRUCTIVE TECHNIQUES Final Report**
Vincent C. Janoo and Richard L. Berg Nov. 1990 62 p
Sponsored by FAA, Washington, DC
(DA Proj. 4A7-62784-AT-42)
(CRREL-90-10; DOT/FAA/RD-90/33) Avail: NTIS HC/MF A04

Four different pavement test sections were subjected to freeze-thaw cycling in the Frost Effects Research Facility (FERF). The test sections, each 610 cm in length, consisted of 15.2 cm of asphalt concrete pavement over a clay subgrade; 15.2 cm of asphalt concrete over 10.2 cm of crushed gravel over a clay subgrade; 5.1 cm of asphalt over 17.8 cm of crushed gravel over 20.3 cm of clean sand over a clay subgrade; and 5.1 cm of asphalt concrete over 25.4 cm of crushed gravel over 12.7 cm of clean sand over clay subgrade. Thermocouples were imbedded throughout the pavement structure and subgrade. During the thawing periods, deflection measurements were made at four locations in each test section using a Dynatest Falling Weight Deflectometer (FWD). The results of the deflection measurement are presented here. An analysis was done to qualify the subgrade strength based solely on FDW measurements. It was also shown that a relationship existed between thaw depth and FWD measurement in the subgrade. Author

# 32 COMMUNICATIONS AND RADAR

Includes radar; land and global communications; communications theory; and optical communications.

For related information see also *04 Aircraft Communications and Navigation* and *17 Space Communications, Spacecraft Communications, Command and Tracking.* For search and rescue see *03 Air Transportation and Safety,* and *16 Space Transportation.*

**N91-17254#** Lawrence Livermore National Lab., CA.
**COMPUTATION OF TWO-DIMENSIONAL MICROWAVE-GENERATED ELECTRON LAYER EVOLUTION IN LOW PRESSURE AIR**
David J. Mayhall, Jick H. Yee, Gregory E. Sieger, and Raymond A. Alvarez 1990 5 p Presented at the 5th National Conference on High-Power Microwave Technology, West Point, NY, 10-15 Jun. 1990
(Contract W-7405-eng-48)
(DE90-011465; UCRL-102086; CONF-9006179-1) Avail: NTIS HC/MF A01

Laboratory experiments in low-pressure (0.1 to 10 torr) air with long (150 to 600 ns) pulse, 2.856 GHz microwave beams, created by single beam reflection from a metal plate at 45 deg inclination, reveal multiple electron density layers toward the incident beam source. To significantly reduce computation time compared to a computer code resolving full RF cycles, a two-dimensional envelope code, based on two different electron density regimes, is developed for simulation of the experiments. The derivation of the equations governing the code is outlined. Calculational results at 1 torr for three incident electric field waveforms are then presented. Computed electron layer appearance times are compared with experimental results from streak photography. For the case of closest agreement, the calculated times differ from the experimental by 5 to 20 percent. Time-resolved calculated electron density distributions are compared with a time-integrated experimental luminosity photograph. Many features are similar in general, but different in detail. A breakdown threshold of approximately 0.057 MV/m is calculated for a trapezoidal pulse with a 55 ns linear rise, an 80 ns flat top, and a 75 ns linear fall. DOE

**N91-17255#** Naval Research Lab., Washington, DC.
**SUPERRESOLUTION TECHNIQUES AND ISAR IMAGING Interim Report, Oct. 1987 - Oct. 1989**
William F. Gabriel (SFA, Inc., Landover, MD.) 21 Sep. 1990 64 p Sponsored by Office of Naval Technology, Arlington, VA
(AD-A227522; NRL-MR-6714) Avail: NTIS HC/MF A04 CSCL 17/9

High-resolution optimal estimation techniques have been applied to the problem area of radar imaging of rotating objects. Typical digital range-Doppler processor operations are described, utilizing several of the many superresolution techniques available in the literature. Their application to the range domain represents new R and D work, wherein multiple scatterers within one range have been resolved without increasing the bandwidth. Simulation

results show the feasibility for achieving superresolution in the Doppler domain only, the range domain only, or both domains jointly in a three-dimensional (3D) processed image. The capability for focusing upon a small section of the overall image and achieving finer detail (magnification) should be particularly useful. It is concluded that superresolution techniques offer a valuable complement to conventional DFT-ISAR image processing, and should permit either higher resolution images from the same samples, or equal quality images from significantly fewer data samples. The reader is cautioned that these techniques are not applicable in certain situations where total coherence exists over the entire observation interval. GRA

**N91-17256#** Air Force Systems Command, Wright-Patterson AFB, OH. Foreign Technology Div.
**APPLICATION OF COMPLEX RAY THEORY IN EM SCATTERING AND RCS ANALYSIS**
Yingzheng Ruan 20 Sep. 1990 27 p Transl. into ENGLISH from Dianzi Xuebao (Peoples Republic of China), v. 7, no. 3, May 1989 p 89-93
(AD-A227557; FTD-ID(RS)T-0535-90) Avail: NTIS HC/MF A03 CSCL 20/14

The complex ray theory provides a simple and useful approach for the analysis of the propagation and scattering of HF EM waves in various complicated environments. This paper deals with complex ray fields in free space, reflection and refraction at a single interface, multiple reflections and transmission through a layered medium, total reflection and critical reflection at a planar interface, diffraction at an edge, complex ray expansion and superposition, as well as RCS calculation by complex ray method. In addition, some numerical results are given. GRA

**N91-17257#** California Univ., Berkeley. Electronics Research Lab.
**TIME DOMAIN SCATTERING OF FOCUSED ELECTROMAGNETIC BEAM BY LOSSY TARGETS Final Report, 1 Aug. 1986 - 30 Sep. 1989**
Kenneth K. Mei 30 Sep. 1989 22 p
(Contract N00014-86-K-0420)
(AD-A227741) Avail: NTIS HC/MF A03 CSCL 20/14

The scattering of focused electromagnetic beams by lossy targets is examined. The broader objective is the general application of time domain computations. So, the research results include a rather broad subject in electromagnetics. They are related to applications of time domain analyses of focused beam, lossy medium, microstrip and microwave components, absorbing boundary conditions and superconductors. Author

**N91-17258#** National Oceanic and Atmospheric Administration, Boulder, CO. Space Environment Lab.
**THE IPS DATA ACQUISITION AND COMMUNICATION SYSTEM**
L. David Lewis and Richard N. Grubb Sep. 1990 72 p
(PB90-106039; NOAA-TM-ERL-SEL-81) Avail: NTIS HC/MF A04 CSCL 17B

The Space Environment Lab agreed on a Joint Operations and Research Plan with the Mullard Radio Astronomy Observatory (MRAO) of the Cavendish Lab., the British Antarctic Survey, and the Rutherford Appleton Lab. in England to utilize the 3.6 hectare array at the MRAO to monitor disturbances in the interplanetary medium travelling out from the Sun. Under the agreement, the SEL provided resources for the refurbishment of the array and in addition agreed to provide computer hardware and software to the MRAO to acquire and process the data from the array. The hardware and software systems are described which were developed by SEL for that purpose. The system called IPS, is composed of a general purpose small computer and operating system, two special purpose hardware modules, and seven software components. Author

**N91-17259*#** Augsburg Coll., Minneapolis, MN.
**A CORRELATIVE INVESTIGATION OF THE PROPAGATION OF ULF WAVE POWER THROUGH THE DAYSIDE MAGNETOSPHERE Status Report, 1 Jul. - 31 Dec. 1990**
Mark J. Engebretson 1990 15 p
(Grant NAGw-1567)
(NASA-CR-187784; NAS 1.26:187784) Avail: NTIS HC/MF A03 CSCL 20N

Three different ULF wave phenomena (azimuthally polarized Pc 3 pulsations, radially polarized Pc 4 pulsations, and solitary Pc 5 pulsations related to solar wind pressure pulses) were studied. The main problems covered are: (1) how do magnetospheric Pc 3-4 pulsations, which appear to originate in the solar wind, enter the magnetosphere, and how is this wave energy transported throughout the magnetosphere once it enters; (2) what is the ULF response of the outer dayside magnetosphere to solar wind pressure pulses; and (3) how do Pc 3-4 pulsations modulate ELF-VLF emissions in the dayside magnetosphere. Y.S.

**N91-17260#** Michigan Univ., Ann Arbor. Radiation Lab.
**MILLIMETER-WAVE RADAR SCATTERING FROM TERRAIN: DATA HANDBOOK, VERSION 2.0 Technical Report, Jan. - Sep. 1990**
Thomas F. Haddack and Fawwaz T. Ulaby 15 Sep. 1990 211 p
(Contract DAAL03-89-K-0056)
(AD-A228392; UMICH-026247-3-T; ARO-26224.2-GS) Avail: NTIS HC/MF A10 CSCL 17/9

A summary is presented of experimental observations of the radar backscatter from terrain, as reported in the literature. The data is at 35, 94, 140 and 225 GHz, primarily at HH, VV, and HV polarizations. The terrain types observed include dry and wet snow, in-covered ground, trees, grasses, asphalt, gravel, and others. GRA

**N91-17261#** General Electric Co., Arlington, VA. Government Services.
**RADAR EXPERIMENTS DATA REDUCTION, AND EXPERIMENTAL TESTS Final Report, Oct. 1988 - Mar. 1990**
Walter O. Loescher Oct. 1990 9 p
(Contract N00014-88-C-2045)
(AD-A228583) Avail: NTIS HC/MF A02 CSCL 17/9

Work performed included software support for the evaluation and development of advanced radar antenna systems, development and maintenance of target identification databases, and the data reduction of raw radar data from field tests. GRA

**N91-17262#** Defence Research Establishment, Ottawa (Ontario). Surface Radar Section.
**MULTICHANNEL DOPPLER PROCESSING FOR AN EXPERIMENTAL LOW-ANGLE TRACKING SYSTEM**
Eloi Bosse and Ross M. Turner May 1990 54 p
(AD-A228598; DREO-1039) Avail: NTIS HC/MF A04 CSCL 17/9

An analysis is presented of the performance requirements for a Multichannel Doppler-Processing Unit (MDPU) which is part of the Experimental Low-Angle Tracking (ELAT) radar system. This Doppler processing unit must perform the following functions: data reduction, signal-to-noise ratio improvement, sea-clutter rejection and correction for systematic errors. Before establishing the Doppler processing requirements, we analyze the characteristics of the sea-clutter as a function of the ELAT radar parameters. Then, the general guidelines are presented for the design of the MDPU, with emphasis on a new method to compensate for systematic errors. Finally, the effects of block sampling on both target detection and target height estimation are considered. GRA

**N91-17263#** Massachusetts Inst. of Tech., Lexington. Lincoln Lab.
**DIVERGENCE DETECTION IN WIND FIELDS ESTIMATED BY AN AIRPORT SURVEILLANCE RADAR**
Terri A. Noyes 15 Oct. 1990 40 p

(Contracts DTFA01-84-Z-02030; DTFA01-83-4-10579; F19629-90-C-0002)
(AD-A228653; ATC-172; DOT/FAA/NR-90/2) Avail: NTIS HC/MF A03 CSCL 17/9

A technique is assessed for automatic detection of hazardous divergence in velocity fields estimated by an Airport Surveillance Radar (ASR). A least squares approach was evaluated to radial divergence estimation through a performance analysis based on simulated data. This approach is compared to an existing decision based radial shear finding method used for the Terminal Doppler Weather Radar (TDWR). Empirical results derived by the application of the two techniques to data collected at ASR testbeds in Huntsville, Alabama and in Kansas City, Missouri are presented. Results indicate that a simple, least squares divergence estimator combined with time association logic to increase temporal continuity of algorithm output is an equally effective means of detecting divergent wind shear in velocity fields estimated from ASR signals. GRA

**N91-17264#** Massachusetts Inst. of Tech., Lexington. Lincoln Lab.
**BEAM FILLING LOSS ADJUSTMENTS FOR ASR-9 WEATHER CHANNEL REFLECTIVITY ESTIMATES**
Cynthia D. Engholm and Seth W. Troxel 23 Oct. 1990 57 p
(Contract DTFA01-L-83-4-10579)
(AD-A228654; ATC-177; DOT/FAA/NR-90/6) Avail: NTIS HC/MF A04 CSCL 17/9

The FAA is deploying over 100 new airport surveillance radars (ASR-9) across the country. In contrast to earlier ASRs, the ASR-9 utilizes a separate digital weather processing channel to provide air traffic controllers with timely, calibrated displays of precipitation intensity. The ASR-9 utilizes dual selectable fan shaped elevation beams designed to track aircraft over a large volume. As a consequence, weather echoes received from these fan shaped beams represent vertically averaged quantities. If the precipitation only partially or nonuniformly fills the beam, then the vertically integrated reflectivity may underestimate the actual intensity of the storm. The ASR-9 weather channel corrects for this by adjusting the range dependent six level reflectivity thresholds. The appropriateness of the currently implemented correction has not been carefully examined and may require modification to take into account regional and morphological variability in storm structure. The method used to derive new beam filling loss adjustments is discussed. An extensive database of volumetric pencil beam radar data were used in conjunction with the ASR-9 simulation facility to derive adjustments aimed at calibrating the precipitation intensity reports to the maximum perceived hazard. Results from this calibration indicate that a single correction is appropriate for all sites and intensities. The new corrections yield substantially improved results over the current corrections in producing these reflectivity reports. GRA

**N91-17265#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**AN EVALUATION OF VOICE STRESS ANALYSIS TECHNIQUES IN A SIMULATED AWACS ENVIRONMENT M.S. Thesis**
William A. Jones, Jr. Aug. 1990 69 p
(AD-A228727; AFIT/CI/CIA-90-115) Avail: NTIS HC/MF A04 CSCL 06/10

The purpose was to determine if voice analysis algorithms are an effective measure of stress resulting from high workload. Fundamental frequency, frequency jitter, and amplitude shimmer algorithms were employed to measure the effects of stress in crewmember communications data in simulated AWACS mission scenarios. Two independent workload measures were used to identify levels of stress: a predictor model developed by the simulation author based upon scenario generated stimulus events; and the duration of communication for each weapons director, representative of the individual's response to the induced stress. Between eight and eleven speech samples were analyzed for each of the sixteen Air Force officers who participated in the study. Results identified fundamental frequency and frequency jitter as statistically significant vocal indicators of stress, while amplitude shimmer showed no signs of any significant relationship with workload or stress. Consistent with previous research, the frequency algorithm was identified as the most reliable measure. However, the results did not reveal a sensitive discrimination measure between levels of stress, but rather, did distinguish between the presence or absence of stress. The results illustrate a significant relationship between fundamental frequency and the effects of stress and also a significant inverse relationship with jitter, though less dramatic. GRA

**N91-17266*#** Space Systems/Loral, Palo Alto, CA. Communications Systems Lab.
**DATA DISTRIBUTION SATELLITE Final Report**
Kent M. Price, Ronald E. Jorasch, and Michael J. Wiskerchen (DYSE Corp., San Jose, CA.) Feb. 1991 311 p
(Contract NAS3-25092)
(NASA-CR-187066; NAS 1.26:187066; SSL-TR00722) Avail: NTIS HC/MF A14 CSCL 17B

A description is given of a data distribution satellite (DDS) system. The DDS would operate in conjunction with the tracking and data relay satellite system to give ground-based users real time, two-way access to instruments in space and space-gathered data. The scope of work includes the following: (1) user requirements are derived; (2) communication scenarios are synthesized; (3) system design constraints and projected technology availability are identified; (4) DDS communications payload configuration is derived, and the satellite is designed; (5) requirements for earth terminals and network control are given; (6) system costs are estimated, both life cycle costs and user fees; and (7) technology developments are recommended, and a technology development plan is given. The most important results obtained are as follows: (1) a satellite designed for launch in 2007 is feasible and has 10 Gb/s capacity, 5.5 kW power, and 2000 kg mass; (2) DDS features include on-board baseband switching, use of Ku- and Ka-bands, multiple optical intersatellite links; and (3) system user costs are competitive with projected terrestrial communication costs. Author

**N91-17267** Purdue Univ., West Lafayette, IN.
**TARGET MOTION COMPENSATION IN SYNTHETIC APERTURE RADAR Ph.D. Thesis**
Hern-Chung Chen 1990 172 p
Avail: Univ. Microfilms Order No. DA9031308

By collecting data as it moves along a straight line path and then coherently processing this data the synthetic aperture radar (SAR) obtains an angular resolution equivalent to that of a very long antenna. Improvements in resolution of a hundredfold or more over conventional radars are possible in SAR systems. One of the major difficulties in using such systems is the uncertainty in target position that results when targets have a radial velocity component relative to the radar. The SAR processing causes such targets to appear at the correct range but at an erroneous azimuth position. This research is directed toward the investigation of this phenomenon and the development of a signal processing method to reduce or eliminate it. Three different approaches are studied. The first approach is to make use of three antennas on the radar system as a means of determining the velocity components for each target present and providing a basis for shifting them back to their correct azimuth position after SAR processing. The compensation is carried out in the time domain and is continuous along the flight line. The second approach is to use a Doppler-insensitive filter to compensate the phase of incoming signals of the moving target. After compensating, these received signals look like signals reflected from a stationary target. It is a time-consuming process, but has good performance. The third approach is to convert incoming signals to the frequency domain. From this spectrum, the central frequency can be calculated. Meanwhile, the velocity of the target on the ground can be estimated from this central frequency. Using this estimated velocity to design the reference function which is used to correlate the incoming signals, the target location can be found. This method is similar to the conventional SAR signal processing except of

using different reference function. An evaluation is carried out both analytically and by computer simulation. The comparisons between theoretical results and the values from the simulation are prepared. Dissert. Abstr.

**N91-17268*#** Michigan Univ., Ann Arbor. Radiation Lab.
**A COMBINED FINITE ELEMENT-BOUNDARY ELEMENT FORMULATION FOR SOLUTION OF AXIALLY SYMMETRIC BODIES Technical Report, Sep. 1990 - Feb. 1991**
Jeffrey D. Collins and John L. Volakis Jan. 1991 67 p Prepared in cooperation with Pacific Missile Test Center, Point Mugu, CA
(Grant NAG2-541)
(NASA-CR-187886; NAS 1.26:187886; UMICH-025921-18-T)
Avail: NTIS HC/MF A04 CSCL 20N

A new method is presented for the computation of electromagnetic scattering from axially symmetric bodies. To allow the simulation of inhomogeneous cross sections, the method combines the finite element and boundary element techniques. Interior to a fictitious surface enclosing the scattering body, the finite element method is used which results in a sparce submatrix, whereas along the enclosure the Stratton-Chu integral equation is enforced. By choosing the fictitious enclosure to be a right circular cylinder, most of the resulting boundary integrals are convolutional and may therefore be evaluated via the FFT with which the system is iteratively solved. In view of the sparce matrix associated with the interior fields, this reduces the storage requirement of the entire system to O(N) making the method attractive for large scale computations. The details of the corresponding formulation and its numerical implementation are described. Author

**N91-17269#** Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Mathematics.
**PULSE PROPAGATION IN RANDOM MEDIA Final Technical Report, 1 Mar. 1989 - 30 Apr. 1990**
Werner Kohler 11 Jun. 1990 4 p
(Grant AF-AFOSR-0112-88; AF Proj. 6177)
(AD-A229006; AFOSR-90-1091TR) Avail: NTIS HC/MF A01 CSCL 20/14

This report summarizes results obtained in the study of how waves are reflected and transmitted by a randomly layered medium. Temporally pulsed energy (plane wave, beam or radiated energy from a localized source) illuminates this material. Work that was initially done for the acoustic problem has been extended to the electromagnetic problem. An extensive simulation study has confirmed the applicability of this theory. Recent work has considered radiation from a monochromatic point source in the presence of a randomly layered medium. GRA

**N91-17270#** Massachusetts Inst. of Tech., Lexington. Lincoln Lab.
**MILLSTONE ANGLE CALIBRATION, 1989**
A. L. Williams 14 Sep. 1990 100 p
(Contract F19628-90-C-0002)
(AD-A229008; TR-896; ESD-TR-90-088) Avail: NTIS HC/MF A05 CSCL 17/9

Calibration of the Millstone Hill radar is accomplished by the use of several calibration models. This report focuses on the two models used to calibrate azimuth and elevation. Data from both low-altitude and deep space satellites for the year 1989 were used for this study. Of particular interest is the variation of the calibration model parameters over time. This study considers the methods by which these parameters should optimally be determined, and the frequency with which they should be updated. In addition, attempts to model an unexplained jump seen in elevation residuals are discussed. Finally, the tiltmeter calibration models are examined. GRA

**N91-17271#** Naval Research Lab., Washington, DC. Communications Systems Branch.
**THE APPLICATION OF HOPFIELD NEURAL NETWORK TECHNIQUES TO PROBLEMS OF ROUTING AND SCHEDULING IN PACKET RADIO NETWORKS Interim Report, Oct. 1989 - Jul. 1990**
Jeffrey E. Wieselthier, Craig M. Barnhart, and Anthony Ephremides (Locus, Inc., Alexandria, VA.) 9 Nov. 1990 121 p Sponsored by ONR, Arlington, VA
(AD-A229039; NRL-MR-6730) Avail: NTIS HC/MF A06 CSCL 25/2

Although the issues of routing and scheduling in packet radio networks are highly interdependent, few studies have addressed their interactions. In this report, we review the major issues associated with the joint study of these problems, and we address the problem of routing for the minimization of congestion as a first step toward the solution of the joint routing-scheduling problem. We formulate this as a combinatorial optimization problem, and we develop a Hopfield neural network (NN) model for its solution. The issues associated with the development of the Hopfield NN model for this problem are discussed in detail. In particular, the determination of the coefficients in the connection weights is the most critical issue in the design and simulation of Hopfield NN models. In our studies, we use the method of Lagrange multipliers, which permits these coefficients to vary dynamically along with the evolution of the system state. Extensive software simulation results demonstrate the ability of our approach to determine good sets of routes in large, heavily-congested networks. GRA

**N91-17272#** Army Engineer Waterways Experiment Station, Vicksburg, MS. Information Technology Lab.
**WES FIBER OPTICS ETHERNET COMMUNICATION SYSTEM Final Report**
Michael G. Ellis Jun. 1990 76 p
(AD-A229058; WES/TR/ITL-90-5) Avail: NTIS HC/MF A05 CSCL 25/5

The development of an advanced plan for office automation, the proposed implementation of an onsite supercomputer, and the imminent plans for a corporate data base will overburden the existing communication network at the U.S. Army Engineer Waterways Experiment Station (WES). These events have accelerated the requirements for WES to upgrade its current communications network to handle the needs of the next 25 years. Plans have been formulated to integrate the data requirements of the entire WES site by constructing a high-speed fiber optic backbone network to handle any type of communication requirements. The ultimate objective is to allow any user to transparently communicate with any other device on the network. GRA

**N91-17273#** Naval Research Lab., Washington, DC. Communication Systems Branch.
**PERFORMANCE EVALUATION OF MULTI-ACCESS STRATEGIES FOR AN INTEGRATED VOICE/DATA CDMA PACKET RADIO NETWORK Interim Report, Sep. 1989 - Apr. 1990**
Evaggelos Geraniotis and Mohsen Soroushnejad (Maryland Univ., College Park.) 9 Nov. 1990 47 p Sponsored by ONR, Arlington, VA
(AD-A229155; NRL-MR-6743) Avail: NTIS HC/MF A03 CSCL 25/2

The problem of voice/data integration in a random-access radio network employing the ALOHA protocol in conjunction with retransmission control is investigated. Channel-access control strategies are introduced that take advantage of the capability of the code-division multiple-access (CDMA) channel to accommodate several voice calls simultaneously, while the data users contend for the remaining (if any) multiple-access capability of that channel. The retransmission probabilities of the backlogged data users are updated based on estimates of data backlog and number of established voice calls, which are obtained from the side information about the state of channel activities. A two-dimensional Markovian model is developed for the voice and data traffic. Based on this model, the voice-call blocking probability, the throughput of both traffic types, and the delay of the data packets are evaluated and the tradeoffs between the parameters of different traffic types are quantified. It is observed that by taking advantage of the multiple-access capability of the CDMA channel in the control of

data traffic, we may achieve movable-boundary channel access in the code domain. GRA

**N91-17274#** University of Central Florida, Orlando. Div. of Sponsored Research.
**PERFORMANCE OF DISTRIBUTED SIMULATION USING MULTIPLE SEGMENT ETHERNET COMMUNICATION NETWORKS Final Report, 2 Feb. - 7 Aug. 1990**
Ratan Guha and M. Bassiouni 21 Sep. 1990 58 p
(Contract N61339-90-C-0031)
(AD-A229216) Avail: NTIS HC/MF A04 CSCL 12/7

This paper presents the work with the generalized Petri net (GSPN) models of a simulation network similar to SIMNET, a distributed system of training simulators connected over an Ethernet local area network. In contrast to isolation models, these models use a global approach to represent the details of the interaction among the stations over the network. In our first GSPN model, sixteen chains are used to capture the state of transmission for the sixteen attempts allowed for each node. The frame transmitter process is accurately represented in this model by keeping track of the individual attempts separately and using the correct backoff delay distribution for each attempt. Two modifications of this model are obtained by introducing approximations that allow the execution of networks with a larger number of nodes while maintaining a good degree of accuracy. Results of important performance measures (e.g., frame loss rate due to excessive collision count) obtained from the three models are presented and compared. GRA

# 33 ELECTRONICS AND ELECTRICAL ENGINEERING

Includes test equipment and maintainability; components, e.g., tunnel diodes and transistors; microminiaturization; and integrated circuitry.

For related information see also *60 Computer Operations and Hardware* and *76 Solid-State Physics*.

**N91-17275#** Oak Ridge National Lab., TN.
**THE RESPONSE OF MOV AND SiC ARRESTERS TO STEEP-FRONT LONGER DURATION CURRENT PULSES**
David B. Miller, Hong Bo Fan (North China Inst. of Electric Power, Beijing.), and Paul R. Barnes 1990 6 p Presented at the IEEE/PES 1990 Summer Meeting, Minneapolis, MN, 15-20 Jul. 1990
(Contract DE-AC05-84OR-21400)
(DE90-008572; CONF-900773-1) Avail: NTIS HC/MF A02

An 80 m section of 138 kV transmission cable is used to produce pulses with voltages of several hundred kilovolts, currents greater than 20,000 A and risetimes equal to approximately 50 ns. This line pulser is used to test the response of Metal Oxide Varistors (MOV) and gapped SiC surge arresters to steep-front, high current, 1.4 microsecond duration pulses. The typical arrester voltage during a pulse consists of a very strong initial overshoot voltage spike, followed by a nearly constant residual voltage which lasts to the end of the pulse. The overshoot voltage is believed to be related to the inductance of the arrester/divider circuit; this voltage increases linearly with peak current and is about the same for the MOV and SiC arresters. The residual voltage indicates the protection offered by the arrester due to its voltage clamping action and is larger for the SiC arrester. Replacing the arrester by a similarly sized aluminum tube allows the inductive portion of the response to be removed, and the true arrester response is then seen to be quite fast. DOE

**N91-17276#** Lawrence Livermore National Lab., CA.
**SUBNANOSECOND PHOTOCONDUCTIVE SWITCHING IN GaAs**
R. L. Druce, M. D. Pocha, and K. L. Griffin 1990 22 p Presented at the 1st Los Alamos Symposium on Ultra-Wideband Radar, Los Alamos, NM, 5-8 Mar. 1990
(Contract W-7405-eng-48)
(DE90-011481; UCRL-JC-103782; CONF-900397-3) Avail: NTIS HC/MF A03

We are conducting research in photoconductive switching for the purpose of generating microwave pulses with amplitudes up to 50 kV. This technology has direct application to impulse radar and HPM sources. We are exploiting the very fast recombination rates of Gallium Arsenide (GaAs) to explore the potential of GaAs as an on-off switch when operating in the linear mode (the linear mode is defined such that one carrier pair is generated for each photon absorbed). In addition, we are exploring the potential of GaAs to act as a closing switch in avalanche mode at high fields. We have observed switch closing times of less than 200 psec with 100 psec duration laser pulse and opening times of less than 400 psec with neutron irradiated GaAs at fields of tens of kV/cm. If the field is increased and the laser energy decreased, the laser can be used to trigger photoconductive switches into an avalanche mode of operation in which carrier multiplication occurs. This mode of operation is quite promising since the switches close in less than 1 nsec while realizing significant energy gain (ratio of electrical energy in the pulse to optical trigger energy). We are currently investigating both large area (1 sq cm) and small area (less than 1 sq mm) switches illuminated by GaAlAs laser diodes at 900 nm and Nd:YAG lasers at 1.06 micrometers. Preliminary results indicate that the closing time of the avalanche switches depends primarily on the material properties of the devices with closing times of 300 to 1300 psec at voltages of 6 to 35 kV. We will present experimental results for linear, lock on and avalanche mode operation of GaAs photoconductive switches and how these pulses may be applied to microwave generation. DOE

**N91-17277*#** Old Dominion Univ., Norfolk, VA.
**ALGORITHM TO ARCHITECTURE MAPPING MODEL (ATAMM) MULTICOMPUTER OPERATING SYSTEM FUNCTIONAL SPECIFICATION Interim Report, Feb. - Aug. 1990**
R. Mielke, J. Stoughton, S. Som, R. Obando, M. Malekpour, and B. Mandala Washington NASA 1990 74 p
(Contract NCC1-136)
(NASA-CR-4339; NAS 1.26:4339) Avail: NTIS HC/MF A04 CSCL 09C

A functional description of the ATAMM Multicomputer Operating System is presented. ATAMM (Algorithm to Architecture Mapping Model) is a marked graph model which describes the implementation of large grained, decomposed algorithms on data flow architectures. AMOS, the ATAMM Multicomputer Operating System, is an operating system which implements the ATAMM rules. A first generation version of AMOS which was developed for the Advanced Development Module (ADM) is described. A second generation version of AMOS being developed for the Generic VHSIC Spaceborne Computer (GVSC) is also presented. Author

**N91-17278** British Petroleum Co. Ltd., London (England).
**FIELD EFFECT TRANSISTORS Patent Application**
Philip Charles Allen, inventor (to British Petroleum Co. Ltd.), Richard Henry Friend, inventor (to British Petroleum Co. Ltd.), and Jeremy Henly Burroughes, inventor (to British Petroleum Co. Ltd.) 22 Jun. 1988 10 p
(EP-PATENT-0-298-628-A2; EP-PATENT-APPL-SN-88305698-8; INT-PATENT-CLASS-H01L-29/28; INT-PATENT-CLASS-H01L-29/78; ETN-90-97968) Avail: UK Patent Office, 254 Southampton Buildings, London WC2A 1A4, England

A patent is claimed for an invention relating to Metal Insulator Semiconductor Field Effect Transistors (MISFECTs) in which organic polymers are used as the semiconducting component. The FET has a gate electrode deposited on a substrate and separated from a semiconducting layer by an insulating layer, the semiconducting layer being provided with two terminals to allow passage of an electric current. The inventive feature is the use of a coherent, conducting organic polymer selected from poly-(acetylene), poly(thienylene vinylene), poly(furanylene vinylene) and substituted derivatives thereof as the semiconducting layer.

The invention is described and illustrated with a drawing of a transverse section through the channel region of a typical FET according to the invention. ESA

**N91-17279** New South Wales Univ., Kensington (Australia). Dept. of Communications.
**NONLINEAR SMOOTHING FILTERS AND THEIR REALIZATION Ph.D. Thesis**
Jim Siu Jimmy Li Feb. 1989 3 p
Avail: Issuing Activity

A novel filter called the median proximate selective regression (MPSR) filter is proposed aiming at minimizing signal distortion caused by median and related non-linear smoothing operations. The MPSR filter can preserve sharp edges and satisfactorily remove impulsive and other types of noise, such as Gaussian noise. Also problems in preserving features of low dimensionality, such as a thin line in two-dimensional space, by two-dimensional non-linear smoothers are investigated. A new class of multi-shell min/max median filters developed from a one-dimensional median filter is introduced to tackle these problems. Dissert. Abstr.

**N91-17280#** National Inst. of Standards and Technology, Gaithersburg, MD. Electromagnetic Fields Div.
**MEASUREMENT OF ELECTRIC FIELD STRENGTH NEAR HIGHER POWERED PERSONAL TRANSCEIVERS**
J. Adams, D. Wu, and A. Budlong May 1990 60 p
(PB91-107268; NISTIR-90/3938) Avail: NTIS HC/MF A04 CSCL 09C

The results are presented of tests conducted on typical transceivers in the four frequency bands used by the law enforcement community: 30 to 50, 150 to 174, 400 to 520, and 806 to 866 MHz. The fields were measured at distances likely to be encountered in practice. Electric field strengths were measured at a number of points near 5 W personal transceivers. The points were located on cylinders of revolution around the antenna with radii of 7, 9.5, 12, 14.5, 17, and, in some cases, 27, 37, and 47 cm. At shorter distances, these measured values exceeded the exposure limits suggested in ANSI Standard C95.1-1982. Author

**N91-17281#** National Inst. of Standards and Technology, Gaithersburg, MD. Electronic Instrumentation and Metrology Group.
**NIST DIGITALLY SYNTHESIZED POWER CALIBRATION SOURCE Final Report**
N. M. Oldham, O. B. Laug, B. C. Waltrip, and R. H. Palm Aug. 1990 64 p
(PB91-107474; NIST/TN-1281) Avail: NTIS HC/MF A04; also available SOD HC $3.25 as 003-003-03033-3 CSCL 09C

A digitally-synthesized source of phantom power for calibration electrical power and energy meters is described. Independent sources of voltage, current, and phase angle are programmable between 0-240 volts, 0-5 amps, and 0-360 degrees, respectively. The uncertainty of the active and reactive power is estimated to be within +/- 100 ppm of the full scale apparent power (volt-amps). GRA

**N91-17282#** National Inst. of Standards and Technology, Gaithersburg, MD. Semiconductor Electronics Div.
**CENTER FOR ELECTRONICS AND ELECTRICAL ENGINEERING TECHNICAL PUBLICATION ANNOUNCEMENTS COVERING CENTER PROGRAMS, JANUARY - MARCH, 1990, WITH 1990 CEEE EVENTS CALENDAR**
J. A. Gonzales Sep. 1990 24 p
(PB91-107201; NISTIR-4423) Avail: NTIS HC/MF A03 CSCL 09C

The 24th issue of the quarterly publication provides information on the technical work of the National Institute of Standards and Technology (NIST) Center for Electronics and Electrical Engineering (CEEE). Abstracts are provided by technical area for papers published during the time period. Some technical areas are as follows: Semiconductor Technology Program; Signal and Systems Metrology Program; Fast Signal Acquisition, Processing, and Transmission; Electrical Systems; and Electromagnetic Interference. Author

**N91-17283#** Royal Signals and Radar Establishment, Malvern (England).
**TECHNIQUES FOR INVESTIGATING THIN-FILM INSULATORS UNDER HIGH ELECTRIC FIELDS**
M. I. J. Beale Sep. 1990 31 p
(RSRE-MEMO-4401; BR115042; ETN-91-98414) Copyright
Avail: NTIS HC/MF A03

Techniques developed to investigate thin film metal-insulator-metal devices operating under high electric fields are described as a practical guide to the experimental list. Typically, the insulator will be a wide band gap, optically active material with device applications including displays and electro-optic components. A battery of approaches, some novel, some not, which provide a strategy for the acquisition of reliable data on this type of sample are given. Emphasis is placed on techniques to cope with the common problems of non uniform conduction and of dielectric breakdown. Techniques are described for the measurement, in near real time, of both the electrical characteristics and the optical spectral response. Reference is made to the behavior of the ZnS:Mn electroluminescent system to illustrate the techniques described. ESA

**N91-17284#** EIC, Inc., Norwood, MA.
**DEVELOPMENT OF A NICKEL OXIDE/HYDROGEN MULTILAYER BIPOLAR BATTERY FOR PULSED POWER, PHASE 2 Final Report, 16 Sep. 1987 - 20 Sep. 1989**
Gerhard L. Holleck, R. David Rauh, B. Aurian-Blajeni, U. M. Twardoch, and B. Jackman 11 Oct. 1990 13 p
(Contract N00014-87-C-0854)
(AD-A228388) Avail: NTIS HC/MF A03 CSCL 10/3

This program is concerned with the development of a nickel oxide/hydrogen battery for pulsed power applications. It is based on thin film nickel oxide cathodes and metal hydride (e.g., LaNi5) anodes. Thin film nickel oxides were prepared by reactive RF sputtering, chemical vapor deposition, anodic oxidation of nickel and by both cathodic and anodic precipitation of nickel hydroxide. Thin LaNi5 files were prepared by RF sputtering from a target of the same composition. Initial nickel oxide pulse currents were several hundred mA/sq cm. Only a fraction of the electrode capacity as accessible at short times less than 10 msec. The LaNi5 electrodes were electrochemically reversible for the H storage reaction, and pulse currents of thin film LaNirHx electrodes were of the same magnitude as the nonsputtered NiOx. Rates appear limited by surface reaction kinetics and by bulk diffusion in the anode and cathode, respectively. GRA

**N91-17285#** California Univ., Los Angeles. Dept. of Electrical Engineering.
**ON THE MODELING AND EXPERIMENTATION OF ELECTROMAGNETICALLY COUPLED MICROSTRIP DIPOLE ARRAYS IN A SUBSTRATE-SUPERSTRATE Final Report, 1 Jul. 1986 - 30 Sep. 1990 Ph.D. Thesis**
Nicholaos G. Alexopoulos and Hung-Ya Yang 1990 262 p
(Contract DAAL03-86-K-0090)
(AD-A228707; ARO-23678.15-EL) Avail: NTIS HC/MF A12 CSCL 09/1

The thrust of the research has been to develop the methodology for the modeling and design antenna arrays and microstrip discontinuities for microwave circuit applications. The thesis involves several key contributions in the subject areas of modeling microstrip discontinuities, microstrip transitions, and the synthesis of microstrip dipole arrays. This work has generated several journal publications within which one finds a fundamental contribution to the understanding of the above mentioned subjects. The analysis and the generated computer programs serve as practical tools for the design of microstrip circuits and microstrip dipole arrays. An evolution of the work has led to the understanding of microstrip discontinuity effects. In particular the theory has been extended to model microstrip bends, T-junctions, four ports, etc. In each case the algorithms account for a precise description of

energy loss at discontinuities due to radiation loss and surface wave loss. These models have also been substantiated with experiment. The models are now extended to provide precise designs for microstrip corporate feeds. This will lead to the design of two dimensional transversely fed electromagnetically coupled dipole arrays. GRA

**N91-17286#** Stanford Univ., CA. Dept. of Materials Science and Engineering.
**INTERMEDIATE TEMPERATURE OXYGEN-CONDUCTING SOLID ELECTROLYTES AND MIXED CONDUCTORS Annual Report No. 2, 1 Sep. 1988 - 31 Aug. 1989**
Turgut M. Guer, Henry Wise, and Robert A. Huggins Sep. 1989 24 p
(Contract GRI-5087-260-1534)
(PB90-260522; SU-MS-1115; GRI-90/0142) Avail: NTIS HC/MF A03 CSCL 09C

Results of work on the partial oxidation of methane to produce useful chemicals using a solid state electrochemical reactor are discussed. Efforts towards the development, synthesis, and characterization of intermediate temperature oxygen-conducting solid electrolytes that might be employed in a novel monolithic solid state electrochemical configuration are described. Such configurations might be interesting for fuel cell, electrochemical oxygen separation, and solid electrolyte enhanced catalysis applications. The design and development of an experimental arrangement and a solid state ionic technique to characterize oxygen ionic transport in mixed conducting perovskite-based oxides under concentration gradients are presented. Author

**N91-17287#** National Inst. of Standards and Technology, Gaithersburg, MD.
**HIGH CURRENT, VERY WIDE BAND TRANSCONDUCTANCE AMPLIFIER Patent Application**
O. B. Laug, inventor (to NIST) 21 Sep. 1989 20 p
(PB90-238627; US-PATENT-APPL-SN-410387) Avail: NTIS HC/MF A03 CSCL 09A

The present invention relates to high current transconductance amplifiers that are stable over a very wide bandwidth. The invention overcomes current/frequency limitations by utilizing the inherent tendency for parallel current motors to add currents so that the sum is independent of frequency, thus obviating the need for a single low-resistance high quality current shunt. The input and output of complementary unipolar current-mirror cells are paralleled. Each cell has a fixed current gain determined by the ratio of two resistors. A differential input voltage to current circuit drives the cell array. The design has the advantage of avoiding the need for a single low resistance current sensing resistor and the attendant problems inherent in such resistors. The invention includes a modification of the basic idea of using complementary current sources or current mirrors with an operational amplifier to obtain a bipolar voltage controlled current source. GRA

**N91-17288#** National Center for Health Statistics, Hyattsville, MD.
**CATALOG OF ELECTRONIC DATA PRODUCTS**
Jul. 1990 82 p
(PB90-272154; DHHS/PUB/PHS-90-1213) Avail: NTIS HC/MF A05 CSCL 09C

The catalog lists and describes the public-use data files produced by the National Center for Health Statistics (NCHS). More than 500 public-use data files, representing most of the NCHS data collection programs, are available for purchase and use. Public-use data files are prepared and disseminated to speed and enhance access to the full scope of data. NCHS data systems include a national vital registration program; household interview and health examination surveys; surveys of hospitals, nursing homes, physicians, and other health care providers; and other periodic or occasional data collection activities to produce a wide spectrum of health and health-related data. NCHS data users encompass all levels of government, the academic and research communities, and business. The majority of the data files released by NCHS contain microdata to allow researchers to aggregate findings in whatever format appropriate for their analyses. Author

**N91-17289#** Columbia Univ., New York, NY. Dept. of Electrical Engineering.
**PSEUDOMORPHIC NARROW GAP MATERIALS FOR HIGH PERFORMANCE DEVICES Annual Technical Progress Report, 15 Dec. 1989 - 14 Dec. 1990**
Wen I. Wang 2 Nov. 1990 8 p
(Contract N00014-90-J-1536)
(AD-A228828) Avail: NTIS HC/MF A02 CSCL 09/1

Kink-free AlInAs/GaInAs/InP modulation-doped field effect transistors from materials grown under normal molecular beam epitaxy conditions and high transconductance P-channel GaSb MODFET with very low gate leakage currents for complementary circuit applications were developed. A hot electron bipolar transistor (Auger transistor) was studied theoretically to show that a substantial improvement over conventional HBTs due to the reduced base resistance. It was also demonstrated theoretically that dominant Auger process in InGaSb/AlGaSb strained quantum well structures can be suppressed. GRA

**N91-17290#** Hughes Research Labs., Malibu, CA. Dept. of Exploratory Studies.
**APPLICATIONS RESEARCH STUDIES OF MICROTUBULES Monthly Letter Progress Report No. 34, 12 May - 15 Jun. 1990**
J. David Margerum 25 Jun. 1990 6 p
(Contract N00014-87-C-2354)
(AD-A228832) Avail: NTIS HC/MF A02 CSCL 09/5

Techniques are studied which are basic to novel applications of lipid microtubules (micro Ts) for electro-optical, optical, and sensor devices, and to study the feasibility of such device applications. The overall program has two main areas: the study of ordered microtubules in fluids and films, for applications such as variable transmission windows, IR polarizers, and microwave phase shifters; and the study of ordered attachment of microtubules to surfaces, for applications such as nonlinear optical devices and acoustic detectors. The emphasis in the second year is on the suspension, orientation and electro-optical properties of metallized microtubules in fluids and polymers, especially in regard to potential applications as radar shutters, lenses, and phase shifters. Techniques for controlling the orientation and attachment of microtubules to surfaces is also being studied in regard to acoustical detector applications. GRA

**N91-17291#** North Carolina Agricultural and Technical State Univ., Greensboro.
**APPLICATION OF ERROR CORRECTING CODES IN FAULT-TOLERANT LOGIC DESIGN FOR VLSI CIRCUITS Annual Report, 1 Jun. 1989 - 31 May 1990**
P. K. Lala and H. L. Martin 31 May 1990 21 p
(Contract F49620-89-C-0069)
(AD-A228840; AFOSR-90-1065TR) Avail: NTIS HC/MF A03 CSCL 09/1

It is now generally accepted that not all faults in VLSI logic can be represented by the stuck-at-0 and stuck-at-1 models used at the gate level. In order to ensure realistic modeling, faults should be considered at the transistor level, since only at the level the complete circuit structure is known. In other words, test for circuits should be derived based on possible shorts and opens at the transistor level. A stuck-open or stuck-closed transistor can be modeled by replacing the faulty transistor with an open connection or a direct short respectively between the transistor's source and drain. GRA

**N91-17292#** California Inst. of Tech., Pasadena.
**OPTOELECTRONIC REALIZATIONS OF NEURAL NETWORK MODELS Final Technical Report, 1 Aug. 1988 - 28 Feb. 1990**
Amnon Yariv, A. Agranat, C. Neugebauer, and V. Leyva 12 Oct. 1990 22 p

(Contract F49620-88-C-0112; DARPA Order 6485)
(AD-A228841; AFOSR-90-1068TR) Avail: NTIS HC/MF A03
CSCL 12/9

This research project is aimed at developing silicon based implementations of neural network models. The main advantages of the approach are its use of standard, present day technology and its highly paralleled memory due to the use of optics. Two different embodiments of the electronic part of the neural processor were realized. A phototransistor based network using standard complementary metal oxide semiconductors technology was built and tested. The CCD version of the optoelectronic architecture was fabricated and tested, proving the viability of this architecture. All electronic loading was explored and offers possibilities of rugged, compact systems. GRA

**N91-17293#** California Univ., Los Angeles. Dept. of Electrical Engineering.
**MULTIPLE OPTICAL PROBING OF HIGH FREQUENCY SEMICONDUCTOR DEVICES Final Report, 15 Nov. 1988 - 14 Nov. 1989**
Harold Fetterman 14 Nov. 1989 48 p Sponsored in part by Hughes Research Labs.
(Grant AF-AFOSR-0111-89; AF Proj. 3842)
(AD-A228842; AFOSR-90-1129TR) Avail: NTIS HC/MF A03
CSCL 09/1

The purchase was made of a complete Nd:YAG pumped picosecond dye laser and related optical components. Matching support was provided for an autocorrelator, power meters, lock-in detectors and Optical Table to form a complete measurement system. The idea was to fabricate a picosecond system which would measure devices and systems out to at least 200 GHz. It would be used to validate Network analyzer measurements in the region of overlap and to develop a degree of confidence in the entire technique of S parameter measurement using picosecond pulses. The highest frequency GaAs and GaAs alloy devices were investigated. New types of devices, MMIC amplifiers and finally the operational constraints of optical interconnections were studied. The system proved to be so useful that all of these tests were preformed and were extended to the generation of millimeter radiation and the demonstration of spectroscopic use. Current measurements are on ballistic field effect devices and resonant tunneling structures which were fabricated by local industries and universities directly as a result of this unique measurement capability. GRA

**N91-17294#** Brookhaven National Lab., Upton, NY. Instrumentation Div.
**RADIATION DAMAGE TESTING OF TRANSISTORS FOR SSC FRONT-END ELECTRONICS**
J. Dawson, T. Ekenberg, A. Stevens, H. Kraner, V. Radeka, S. Rescia, and S. Kerns (Vanderbilt Univ., Nashville, TN.) 1990 4 p Presented at the 1990 IEEE Nuclear Science Symposium, Arlington, VA, 23-27 Oct. 1990
(Contract DE-AC02-76CH-00016)
(DE91-005440; BNL-45453; CONF-9010220-18) Avail: NTIS HC/MF A01

Over the ten year expected lifetime of a typical SSC detector operating at the design luminosity of 10(exp 33)/(sq cm)sec, the front-end electronics at large pseudorapidities may receive total doses as high as 20 MRad(Si) of ionizing radiation and 10(exp 16) neutrons/sq cm. Discrete JFETs and monolithic MOS and bipolar transistors have been irradiated at 10 MRad(Si) and 10(exp 14) neutrons/sq cm, and the effect on transfer characteristics and noise performance have been measured. All transistors were still functional after irradiation but suffered increased noise, and the MOS transistors showed significant threshold shifts and increased leakage currents. DOE

**N91-17295#** Central Research Inst. of Electric Power Industry, Tokyo (Japan). Energy and Environment Lab.
**EVALUATION OF A LITHIUM SECONDARY BATTERY FOR LOAD-CONDITIONER USE: EXTENDING THE Li/Mo2 CELL LIFE CYCLE**
Kazuma Kumai, Kaoru Ishihara, Tooru Iwahori, and Toshikatu Tanaka Mar. 1990 26 p In JAPANESE; ENGLISH summary
(DE91-736736; CRIE-T-89029) Avail: NTIS HC/MF A03

A rechargeable lithium molybdenum disulfide (Li/MoS2) cell has high energy density, high efficiency, and a superior rating capability but it has a poor life cycle for load-conditioner use. A Li/MoS2 cell degradation mechanism that extends the life cycle of the cell was determined. The cell life cycle is determined by phenomena such as phase transformation of the cathode material, dendrite formation, and electrolyte decomposition. Approximately 2500 cycles were achieved under shallow depth of discharge operation by limiting the terminal voltages and charge and discharge rates. These results suggest that the load-conditioner goal will be achieved by shallow depth of discharge operation with a higher-energy-density cell. DOE

**N91-17296#** Central Research Inst. of Electric Power Industry, Tokyo (Japan). Energy and Environment Lab.
**EVALUATION OF LITHIUM SECONDARY BATTERY FOR LOAD-CONDITIONER USE: PERFORMANCE AND CHARACTERISTICS OF MOLYBDENUM SULFIDES (Li/MoS2), IMPROVED MOLYBDENUM SULFIDES (Li/MoS2 AND Li/Mo6S8), AND MANGANESE DIOXIDE (Li/MnO2) CELLS**
Kazuma Kumai, Kaoru Ishihara, Tooru Iwahori, and Toshikatu Tanaka Mar. 1990 35 p In JAPANESE; ENGLISH summary
(DE91-736737; CRIE-T-89030) Avail: NTIS HC/MF A03

AA-size rechareable lithium cells including lithium molybdenum sulfide (A-type; Li/MoS2), improved lithium molybdenum sulfides (B-type; Li/MoS2 and Deltacle; Li/Mo6S8), and lithium manganese dioxide (Li/MnO2) have large capacity of 1-2 Wh and relatively-high energy density. They are expected to be a possible candidate for a load conditioner battery. The characteristics of Li/MoS2 (A- and B-type), Li/Mo6S8, and Li/MnO2 cells are described by charge-discharge profile, rate capability, energy efficiency, cycle life, and others by charge-discharge cycle tests. Based on the criterion for load conditioner use, the initial performance is acceptable, but cycle life must be improved. Of these cells, Li/MnO2 is potentially the most desirable. DOE

**N91-17297#** Central Research Inst. of Electric Power Industry, Tokyo (Japan). Energy and Environment Lab.
**CHARACTERISTICS OF LITHIUM/POLYANILINE BATTERY AND CHANGE IN POLYANILINE MORPHOLOGY**
K. Takei, Kaoru Ishihara, and Tooru Iwahori May 1990 38 p In JAPANESE; ENGLISH summary
(DE91-736785; CRIE-T-89054) Avail: NTIS HC/MF A03

Effects that the fine structure change of PAn in Li/polyaniline (PAn) battery exerts on the battery characteristics were studied. In the composition of PAn with varied polymerizing current densities, the diameter of PAn fibril was shortened with the increase of the current density. Fine fibril PAn indicated excellent output characteristics and the discharge capacity (undoped amount) of almost low speed discharge was obtained even in high speed discharge, but the undoped amount was not improved greatly. The positive electrode charge and discharge reaction of PAn is the anion's in and out of the battery electrolyte. With various electrochemical methods, it was made clear that the travel process of the anion in PAn is in the rate-determining step. The travel speed of the anion in PAn obtained as a chemical diffusion coefficient was about 10 (sup minus 13) cm (sup 2)/sec, and it was constant and independent of the fibril diameter. Accordingly, it was estimated that the improvement in the output characteristics brought about by the shortening of the fibril diameter is not based on the increase in the anion travel speed but on the increase in the reaction surface area brought about by the shortening of the diffusion distance and the fibril diameter. DOE

**N91-17298** Purdue Univ., West Lafayette, IN.
**A STOCHASTIC MODELING APPROACH TO REGION- AND EDGE-BASED IMAGE SEGMENTATION Ph.D. Thesis**
Aly A. Farag 1990 189 p
Avail: Univ. Microfilms Order No. DA9031319

The purpose of image segmentation is to isolate objects in a

scene from the background. This is a very important step in any computer vision system since various tasks, such as shape analysis and object recognition, require accurate image segmentation. Image segmentation can also produce tremendous data reduction. Edge-based and region-based segmentation were examined and two new algorithms based on recent results in random field theory were developed. The edge-based segmentation algorithm uses the pixel gray level intensity information to allocate object boundaries in two stages: edge enhancement, followed by edge linking. Edge enhancement is accomplished by maximum energy filters used in one-dimensional bandlimited signal analysis. The issue of optimum filter spatial support is analyzed for ideal edge models. Edge linking is performed by quantitative sequential search using the Stack algorithm. Two probabilistic search metrics are introduced and their optimally is proven and demonstrated on test as well as real scenes. Region-based segmentation was modeled as a MAP estimation problem in which the actual (unknown) objects were estimated from the observed (known) image by a recursive classification algorithm. The observed image was modeled by an autoregressive (AR) model whose parameters were estimated locally, and a Gibbs-Markov random field (GMRF) model was used to model the unknown scene. A computational study was conducted on images having various types of texture images. The issue of parameter estimation, neighborhood selection, and model orders were examined. Dissert. Abstr.

**N91-17299** Purdue Univ., West Lafayette, IN.
**IMAGE SEGMENTATION USING HUMAN VISUAL SYSTEM PROPERTIES WITH APPLICATIONS IN IMAGE COMPRESSION Ph.D. Thesis**
Heidi Aarlien Peterson 1990 254 p
Avail: Univ. Microfilms Order No. DA9031376

In order to represent a digital image, a very large number of bits is required. For example, a 512 x 512 pixel, 256 gray level image requires over two million bits. This large number of bits is a substantial drawback when it is necessary to store or transmit a digital image. Image compression, often referred to as image coding, attempts to reduce the number of bits used to represent an image, while keeping the degradation in the decoded image to a minimum. One approach to image compression is segmentation-based image compression. The image to be compressed is segmented. Once the image is segmented, information is extracted describing the shapes and interiors of the image segments. Compression is achieved by efficiently representing the image segments. An image segmentation technique is proposed which is based on centroid-linkage region growing, and takes advantage of human visual systems (HVS) properties. The parameters for the segmentation algorithm which produce the most visually pleasing segmented images, and demonstrate the effectiveness of the method are systematically determined through subjective experiments. A method is also proposed for the quantization of segmented images based on HVS contrast sensitivity, and investigate the effect of quantization on segmented images. These segmentation and quantization methods are applied in a new compression technique which fits into the category commonly known as second generation image compression methods. The compression method is designed for application single-frame images. Other segmentation-based image compression techniques have typically represented the image segments by encoding the boundaries of the segments. The use of morphological skeletons is proposed to represent the segments. The morphological skeleton of an image is similar to the medial axis. The application of mathematical morphology is described to generate skeletons for the image segments, and the advantages and disadvantages of using morphological skeletons in segmentation-based image compression. Dissert. Abstr.

**N91-17300** Cincinnati Univ., OH.
**VLSI ARCHITECTURES FOR IMAGE, SPEECH, AND SIGNAL PROCESSING Ph.D. Thesis**
Brahmaji Potu 1990 209 p
Avail: Univ. Microfilms Order No. DA9032621

The field of digital signal processing has immensely benefited from the advances in VLSI technology. The speed of the current digital signal processors (DSPs), roughly 25 to 33 Mflops, is still in the voice band range and out of real-time video processing range. Special purpose architectures and processors are required for real-time video processing applications. A new application-specific architecture for vector quantizer/multi-stage vector quantizer (VQ/MSVQ) algorithm is designed and the functional blocks were implemented in 3 micron SCMOS process for real-time video and speech coding applications. Mean-squared error distortion measure is computed extensively in the VQ algorithm. A separate bit-serial pipelined squarer circuit with half the complexity of a multiplier is also designed for such applications. Besides, architecture using parallel arithmetic number systems - residue number system (RNS) and signed-digit number system (SDNS) for digital signal processing are attempted. First, an architecture for general purpose digital signal processor employing SDNS is designed. Secondly, a digital architecture for the Hopfield neural network model is designed with digit-pipelined parallel arithmetic using signed-digit and modified signed-digit number systems to reduce the computational complexity. Various digital implementations of Hopfield neural network model are critically evaluated through simulations. Also, high-speed A/D converter architectures based on residue number systems, multiple folding, and subranging are also designed for consumer video and high-resolution digital audio applications. Dissert. Abstr.

**N91-17301#** Naval Postgraduate School, Monterey, CA. Dept. of Electrical Engineering.
**INSTANTANEOUS POWER SPECTRUM M.S. Thesis**
Elizabeth H. Stitz Mar. 1990 122 p
(AD-A229098) Avail: NTIS HC/MF A06 CSCL 12/3

The estimation of time varying spectra is a complicated one. The use of classical techniques coupled with the local stationarity assumption is met with only moderate success. Of the many time frequency distribution functions used in the signal analysis, none present fully satisfactory spectra. The performance of the spectrogram, Instantaneous Power Spectra (IPS) the Wigner-Ville Distribution (WD) and various aspects of the Rihaczek distribution (RD) for a variety of signal nonstationarities are compared. WD has the most narrow main-lobes but suffers from spectral cross-terms. IPS, the real part of the RD consistently shows a broadened main-lobe without cross-terms. The squared magnitude of the RD places sharp peaks along the crest of the main-lobe and is otherwise very similar to IPS. The imaginary part of the RD shows a sensitivity to discontinuous frequency changes i.e., frequency shift keying. GRA

**N91-17302#** Tel-Aviv Univ. (Israel).
**ADVANCED CALCIUM-THIONYL CHLORIDE HIGH-POWER BATTERY Final Periodic Technical Report, 15 May 1989 - 15 May 1990**
Emanuel Peled 15 Aug. 1990 52 p
(Contract DAJA45-89-C-0013)
(AD-A229168; R/D-5899A-CH-01) Avail: NTIS HC/MF A04 CSCL 10/3

In this phase it is demonstrated that Ca/SrX2 + 7 or 20 percent SO2-TC cells (A7 and A20 types) can deliver at RT up to 5.5 Ah at low rates and 4.4 Ah at 0.9 A. These cells have 10 to 80 percent more capacity than have commercial Li-TC and Li-SO2 wound c-size cells. The improved A7 and A20 types cells lost almost no capacity after 4 to 5 weeks of storage at 70 C. The A20 type cell generates less heat at 20 C under OCV conditions than equivalent Li/TC cells, having the same electrode area, i.e., it has a longer shelf life. The addition of P40 additive to SrX2 + TC + SO2 solutions decrease further the corrosion rate of calcium. The lowest corrosion rate found for solutions containing 20 percent SO2 + 0.3 percent P40. Formulation of the SrX2-TC electrolyte with 20 percent SO2 and 0.3 percent P40 (A20S type cell) found to have the following advantages: it increases shelf life, it increases load voltage and Faradaic efficiency. A preliminary specification of A20S type Ca-TC cell is enclosed. The improved shelf-life of calcium in BaX2/TC solutions as compared to CaX2/TC solutions results mainly for the difference in the solubility or reactivity of

the CaO film in those two solutions. In CaX2/TC solutions the oxide dissolves leaving the calcium with a CaCl2 layer which does not provide the metal with good protection. In BaX2/TC solutions, on the native CaO layer a BaCl2+AlCl3 or Al2O3 layer is formed. This BaCl3+AlCl3+Al2O3 layer does not form when the oxide is missing from the surface. GRA

**N91-17303#** Minnesota Univ., Minneapolis. Corrosion Research Center.
**INTERFACIAL STABILITY OF LITHIUM IN NON-AQUEOUS GEL POLYMER ELECTROLYTE CELLS Technical Report, 1 Jan. 1989 - 1 May 1990**
P. S. S. Prasad, B. B. Owens, W. H. Smyrl, Alessandro Selvaggi, and Bruno Scrosati (Rome Univ., Italy ) 1 May 1990 3 p Presented at the 178th Meeting of the Electrochemical Society, Seattle, WA, Oct. 1990 Sponsored by DARPA
(Contract N00014-88-K-0360)
(AD-A229186; TR-28-ONR) Avail: NTIS HC/MF A01 CSCL 10/3

Solid polymer electrolytes (SPE) prepared by crosslinking non-aqueous gel polymer precursors in dimethyl sulfoxide-lithium salt media were investigated by a.c. conductivity measurements. These materials exhibit an ionic conductivity of about 10-3 S/cm at 25 C. Electrochemical cells of the type Li/SPE/Li and Li/SPE/M where M = Ni, Al and SS were fabricated. Cyclic voltammograms on the asymmetric cells indicate that the electrolyte decomposition potential is about 3.6 volts. The shape of the repetitive cyclic voltammograms within the stability domain indicated that the lithium plating/stripping process is more efficient in the case of Li/SPE/Ni and Li/SPE/Al than Li/SPE/SS asymmetric cells. The a.c. impedance measurements on symmetric Li/SPE/Li cells exhibited two well define semi-circles with three intercepts on three real-axis. The observed increase in impedance with time was indicative of passivating film formation at the interface. The growth of the film stabilized at a finite value, permitting lithium cyclability. GRA

**N91-17304#** Surrey Univ., Guildford (England).
**WORKSHOP ON MQW MIXING AND ITS APPLICATION TO OPTOELECTRONIC DEVICES**
B. L. Weiss, J. M. Zavada, B. J. Sealy, D. Sadana, and M. A. Littlejohn (North Carolina State Univ., Raleigh.) Aug. 1990 8 p Workshop held in St. Helier, Jersey, (England), 18-21 Sep. 1990
(Grant DAJA45-90-M-0056)
(AD-A229205; R/D-6343-EE-03) Avail: NTIS HC/MF A02 CSCL 09/5

Papers are presented from the workshop. Some of the areas of interest are listed: GaInAs(P)-InP MQW Mixing by Zn Diffusion, Ge and S Implantation for Optoelectronic Applications, Cation Diffusion in InP/In(0.53)Ga(0.47)As Superlattices: Strain Build-Up and Relaxation, Advanced Materials Characterization of Electronic Device Structures, Order-Disorder Ternary Alloys by Atomic Layer Epitaxy, Disordering of Superlattices for Laser Applications, Non-Destructive Characterization of AlAs/GaAs Superlattices by Optical Reflection, Disordered Delineated Waveguides in GaAlAs/GaAs and GaInAs/InP MQW Structures, Post Growth Tailoring of the Optical Properties of GaAs-AlGaAs Quantum Well Structures, Partial Intermixing of Strained InGaAs/GaAs Quantum Wells, and Future Trends. GRA

**N91-17305#** Alabama A & M Univ., Huntsville.
**A ONE-WIRE BATTERY MONITORING SYSTEM WITH APPLICATIONS TO ON-BOARD CHARGING FOR ELECTRIC VEHICLES**
Dieter Nowak 8 Oct. 1990 48 p Prepared for Edgerton, Germeshausen and Grier, Inc., Idaho Falls, ID
(Contract DE-AC07-76ID-01570)
(DE91-005922; DOE/ID-10302) Avail: NTIS HC/MF A03

A on-board charge system which utilizes a one-wire system for voltage monitoring is discussed and test results obtained using the system are presented. The system consists of the following: (1) a 20 kHz high frequency charger; (2) a charge algorithm for lead-acid batteries with gelled electrolyte, such that gassing is avoided; (3) the control system to implement this charge algorithm; and (4) a one-wire battery monitoring system to provide cell/module voltage information to the battery charge controller. Prototype elements of the system have been tested and the system was installed into an EVA Pacer electric vehicle. Charge tests are performed and data taken with the system installed. All elements of the system functioned properly under user conditions. In particular, the charger demonstrated good efficiency, near unity power factor and full programmability. The charge controller functioned reliably and without flaw. The one-wire monitoring system which permits monitoring of cell/module voltages in a battery pack without an extensive conventional wire harness has proven effective and voltage measurements were taken fast enough for control of charging. It was found that for the purpose of voltage monitoring under driving conditions, the system in its present form is too slow. DOE

**N91-17306#** Sandia National Labs., Albuquerque, NM.
**LITHIUM BATTERY SAFETY AND RELIABILITY**
Samuel C. Levy 1991 12 p Presented at the 5th International Seminar on Lithium Battery Technology and Applications, Deerfield Beach, FL, 4-8 Mar. 1991
(Contract DE-AC04-76DP-00789)
(DE91-005800; SAND-91-0012C; CONF-910344-1) Avail: NTIS HC/MF A03

Lithium batteries have been used in a variety of applications for a number of years. As their use continues to grow, particularly in the consumer market, a greater emphasis needs to be placed on safety and reliability. There is a useful technique which can help to design cells and batteries having a greater degree of safety and higher reliability. This technique, known as fault tree analysis, can also be useful in determining the cause of unsafe behavior and poor reliability in existing designs. DOE

**N91-17307#** Edgerton, Germeshausen and Grier, Inc., Idaho Falls, ID.
**ELECTRONIC SYSTEMS MINIATURIZATION USING PROGRAMMABLE LOGIC DEVICES**
E. C. Ashton and G. C. Bergeson Oct. 1990 53 p
(Contract DE-AC07-76ID-01570)
(DE91-006214; EGG-EE-9258) Avail: NTIS HC/MF A04

This report describes the steps which were taken to miniaturize a target circuit using Erasable Programmable Logic Devices (EPLDs). The original objective of this project was to explore the miniaturization of a circuit using both Application Specific Integrated Circuits (ASICs) and EPLDs to meet the following goals: balance cost and circuit density; reduce fabrication time; improve quality control issues by keeping much of the design in-house; and eliminate security risks by partitioning the design into ASIC and PLD (EPLD) sections. Due to cost considerations, the target circuit was miniaturized using only PLDs. The results of this project indicate that PLDs are capable of realizing fairly dense circuitry, are considerably less expensive than ASICs (by a factor of 500 to 1000), and are able to eliminate security risks and reduce fabrication time by keeping the design completely in-house. DOE

**N91-17308#** Lawrence Livermore National Lab., CA.
**TIME RESPONSE OF FAST-GATED MICROCHANNEL PLATES USED AS X RAY DETECTORS**
R. E. Turner, P. Bell, R. Hanks, J. D. Kilkenny, N. Landen, G. Power, J. Wiedwald, and M. Meier Nov. 1990 20 p Presented at the 32nd Annual Meeting of the American Physical Society - Division of Plasma Physics, Cincinnati, OH, 12-16 Nov. 1990
(Contract W-7405-eng-48)
(DE91-006243; UCRL-JC-105315; CONF-9011127-11) Avail: NTIS HC/MF A03

We report measurements of the time response of fast-gated, micro-channel plate (MCP) detectors, using a less than 10 ps pulsewidth ultra-violet laser and an electronic sampling system to measure time resolutions to better than 25 ps. The results show that framing times of less than 100 ps are attainable with high gain. The data is compared to a Monte Carlo calculation, which shows good agreement. We also measured the relative sensitivity

as a function of dc bias, and saturation effects for large signal inputs. In part B, we briefly describe an electrical time-of-flight technique, which we have used to measure the response time of a fast-gated microchannel plate (MCP). Thinner MCP's than previously used have been tested and, as expected, show fast gating times and smaller electron multiplication. A preliminary design for an x ray pinhole camera, using a thin MCP, is presented. DOE

**N91-17043*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**ADVANCED ELECTRICAL POWER, DISTRIBUTION AND CONTROL FOR THE SPACE TRANSPORTATION SYSTEM**
Irving G. Hansen and Henry W. Brandhorst, Jr. *In* NASA, Washington, Space Transportation Avionics Technology Symposium. Volume 2: Conference Proceedings Aug. 1990 p 569-579 (For primary document see N91-17020 09-06)
Avail: NTIS HC/MF A99 CSCL 09C

**N91-17569*#** Computational Logic, Inc., Austin, TX.
**THE DESIGN AND PROOF OF CORRECTNESS OF A FAULT-TOLERANT CIRCUIT**
William R. Bevier and William D. Young *In* NASA, Langley Research Center, NASA Formal Methods Workshop, 1990 Nov. 1990 15 p (For primary document see N91-17559 09-61)
Avail: NTIS HC/MF A22 CSCL 09C

# 34 FLUID MECHANICS AND HEAT TRANSFER

Includes boundary layers; hydrodynamics; fluidics; mass transfer; and ablation cooling.

For related information see also *02 Aerodynamics* and *77 Thermodynamics and Statistical Physics.*

**N91-17309#** International Centre for Theoretical Physics, Trieste (Italy).
**LUMINOSITY PROFILES AND THE EVOLUTION OF SHOCK WAVES IN GENERAL RELATIVISTIC RADIATING SPHERES**
Luis Herrera and L. A. Nunez (Universidad de Los Andes, Merida, Venezuela ) Oct. 1989 37 p Previously announced in IAA as A91-16475
(DE90-622195; IC-89/340) Avail: NTIS (US Sales Only) HC/MF A03

A method recently proposed by the authors to study the evolution of discontinuities in radiating spherically symmetric distributions of matter is systematically applied to model the evolution of a composite radiant sphere. The matter configuration, free of singularities, is divided in two regions by a shock wave front, and at each side of this interface a different equation of state is considered. Solutions are matched across the shock via the Rankine-Hugoniot conditions while the outer region metric joins the Vaidya solution at the boundary surface. The influence on the evolution of these composite spheres of different shapes of neutrino outburst profiles, and particular neutrino-transfer processes from the inner core to the outer mantel is explored. Prospective applications to supernova scenarios are discussed. DOE

**N91-17310*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
**RELATIVE EFFICIENCY AND ACCURACY OF TWO NAVIER-STOKES CODES FOR SIMULATING ATTACHED TRANSONIC FLOW OVER WINGS**
Daryl L. Bonhaus and Stephen F. Wornom Washington Feb. 1991 125 p
(NASA-TP-3061; L-16811; NAS 1.60:3061) Avail: NTIS HC/MF A06 CSCL 20D

Two codes which solve the 3-D Thin Layer Navier-Stokes (TLNS) equations are used to compute the steady state flow for two test cases representing typical finite wings at transonic conditions. Several grids of C-O topology and varying point densities are used to determine the effects of grid refinement. After a description of each code and test case, standards for determining code efficiency and accuracy are defined and applied to determine the relative performance of the two codes in predicting turbulent transonic wing flows. Comparisons of computed surface pressure distributions with experimental data are made. Author

**N91-17311** Virginia Polytechnic Inst. and State Univ., Blacksburg.
**FLUX-SPLIT ALGORITHMS FOR FLOWS WITH NON-EQUILIBRIUM CHEMISTRY AND THERMODYNAMICS Ph.D. Thesis**
Pasquale Cinnella 1989 188 p
Avail: Univ. Microfilms Order No. DA9017018

New flux-split algorithms are developed for high velocity, high temperature flow situations, when finite-rate chemistry and non-equilibrium thermodynamics greatly affect the physics of the problem. Two-vector-split algorithms, of the Steger-Warming and of the Van Leer type, and one flux-difference-split algorithm of the Roe type are established and utilized for the accurate numerical simulation of flows with dissociation, ionization, and combustion phenomena. Several thermodynamic models are used, including a simplified vibrational non-eqilibrium model and an equilibrium model based upon refined statistical mechanical properties. The framework provided is flexible enough to accommodate virtually any chemical model and a wide range of non-equilibrium, multi-temperature thermodynamic models. A theoretical study of the main features of flows with free electrons, for conditions that require the use of two translational temperatures in the thermal model, is developed. A simple but powerful asymptotic analysis is developed which allows the establishment of the fundamental gas dynamic properties of flows with multiple translational temperatures. The new algorithms developed demonstrate their accuracy and robustness for challenging flow problems. The influence of several assumptions on the chemical and thermal behavior of the flows is investigated, and a comparison with results obtained using different numerical approaches, in particular spectral methods, is provided, and proves to be favorable to the present techniques.
Dissert. Abstr.

**N91-17312#** Texas A&M Univ., College Station. Dept. of Mechanical Engineering.
**INVESTIGATION OF A TAPERED ARTERY MICRO HEAT PIPE FOR COOLING CERAMIC CHIP CARRIERS Final Report, Jan. 1989 - Feb. 1990**
G. P. Peterson and D. Wu 30 Apr. 1990 39 p
(Contract F33615-86-C-2723)
(AD-A224925; ME-32526-5994; WRDC-TR-90-2028) Avail: NTIS HC/MF A03 CSCL 13/1

This investigation included several major tasks including the expansion of the existing analytical model to predict transient performance, determine the effect of variations in the size, and optimize the cross-sectional shape. In addition, several micro heat pipes which utilized this optimized shape were evaluated experimentally to determine their suitability for removing heat from a ceramic chip carrier. The result was an experimentally verified transient numerical model capable of predicting the onset of dryout in a tapered micro heat pipe during startup or variations in the evaporator thermal load was developed. Comparison of the numerical and experimental results indicate that the numerical model is capable of accurately predicting the maximum transport capacity prior to the onset of dryout, the temperature distribution throughout the longitudinal position, and the temperature difference between different locations on the heat pipe to within 0.3 C prior to the onset of dryout. In addition, the transient model was found to be capable of predicting the operation and temperature distribution of the tapered micro heat pipe to within + or - 12 percent over a wide range of powers and operating temperatures.
GRA

**N91-17313** Illinois Inst. of Tech., Chicago.
**NONLINEAR STABILITY OF A VISCOUS AXISYMMETRIC JET**

**Ph.D. Thesis**
Judith Ann Horwitz 1990 158 p
Avail: Univ. Microfilms Order No. DA9030460

The nonlinear temporal stability of a viscous axisymmetric jet using a hyperbolic tangent approximation to the actual mean flow is studied with respect to axisymmetric and helical disturbances. For the case of axisymmetric disturbances the weakly nonlinear Stuart-Watson perturbation expansion is used to study the self interaction of the fundamental in a neighborhood of the critical Reynolds number (R sub c). The Landau constant is positive indicating there is a supercritical Hopf bifurcation. In order to extend these results past R is approximately R(sub c), a severely truncated Fourier model expansion using the Stuart-Watson functions to represent the r dependence, exponentials in z and unknown amplitudes in time is substituted into the Navier-Stokes equation. A projection onto an appropriate subspace leads to a low dimensional (five) system of amplitude equations for the disturbance of the fundamental, harmonic and distortion to the mean flow. The bifurcation package AUTO and Fourier spectrum are used to characterize the nature of the solutions for various values of R. Dissert. Abstr.

**N91-17314** Pennsylvania State Univ., University Park.
**DEVELOPMENT OF LOCAL/GLOBAL SAW SENSORS FOR MEASUREMENT OF WALL SHEAR STRESS IN LAMINAR AND TURBULENT FLOWS Ph.D. Thesis**
Yongrae Roh 1990 161 p
Avail: Univ. Microfilms Order No. DA9032369

The determination of fluctuating normal and shear stresses on a structure embedded in a turbulent flow is an important problem in fluid dynamics. A new surface acoustic wave (SAW) sensor is developed to detect the surface forces and the direction of laminar and turbulent flows as a function of position and time on the structure. The piezoelectric material used for the sensor is chosen to be PVDF because of its mechanical ruggedness, flexibility, and chemical inertness, with high piezoelectric response and useful acoustic properties. All the material properties were not available. Poled PVDF is of orthorhombic square mm symmetry. All nine complex elastic constants, three complex dielectric constants, and five complex piezoelectric constants were measured as a function of frequency using a thin film and stacked, cubical samples of PVDB film. The elastic constants, the dielectric constants, as well as the piezoelectric constants reported are new. Through numerical simulation, the optimal crystal cut, propagation direction and nondimensional wave number (ka) for all the modes of propagation are obtained for maximum SAW excitation efficiency, minimum attenuation in propagation and pure mode propagation. Through study of the effect of surface forces on a SAW propagation, the concept of the new SAW sensor is theoretically established and experimentally proved both statically and dynamically. With an appropriate center frequency dependent upon the spatial and temporal resolution required, a simultaneous measurement of the fluctuating surface forces and the direction of laminar and turbulent flows is accomplished both locally and globally. The new SAW sensor can overcome the limitations of conventional flow measurement instruments, such as size, sensitivity, surface geometry of a structure, and the interference with a flow field. The SAW sensor was calibrated under static loading and tested in a fully developed turbulent flow facility, and the fluctuation skin friction was measured as a function of time. Dissert. Abstr.

**N91-17315#** Advanced Fuel Research, Inc., East Hartford, CT.
**NOVEL ON-LINE CHARACTERIZATION METHOD FOR SUSPENDED PARTICLES Final Report**
Peter R. Soloman, Philip W. Morrison, Jr., Martin Carangelo, John Haigis, and Philip E. Best May 1990 117 p
(Grant NSF ISI-85-21570)
(PB90-257478; NSF/ISI-90002) Avail: NTIS HC/MF A06
CSCL 20D

The technique was developed to determine the chemical composition, size, and number density distributions of multi-phase particulate and droplet samples. The method is based on measurements of the infrared emission and transmission of the sample using a Fourier Transform Infrared (FT-IR) spectrometer. The technique, called E/T FT-IR, is based on the discovery that for cold particles surrounded by hot walls, the infrared band structure of gas suspended particles appears in the emission spectra. Application of the E/T method is considered practical for the analysis of streams of particles where the particles are already suspended in a gas stream as a result of the process; otherwise, only when emissivities are required. Author

**N91-17316#** National Inst. of Health, Bethesda, MD.
**VARIABLE AIR FLOW EDDY CONTROL Patent Application**
K. Crouch, inventor (to NIH) 23 Aug. 1989 20 p
(PB90-243742; US-PATENT-APPL-SN-397226) Avail: NTIS HC/MF A03 CSCL 20D

The invention relates to apparatus and methods for controlling the flow of fluid around an object. In particular, the present invention relates to apparatus and methods for controlling the formation of eddies and the flow of fluid borne particles around an object located in a fluid flow path. Author

**N91-17317#** Chemical Research and Development Center, Aberdeen Proving Ground, MD.
**HOT FILM VELOCITY MEASUREMENTS DOWNSTREAM OF A SWEPT BACKWARD-FACING STEP Final Report, Jul. 1987 - Jul. 1989**
Daniel J. Weber Aug. 1990 140 p
(AD-A228713; CRDEC-TR-221) Avail: NTIS HC/MF A07
CSCL 20/4

The purpose of this study was to determine the effects of sweep angle of the velocity field around a swept backward-facing step. Three step sweep angles were investigated: 0, 15, and 30 degrees. Velocity measurements were made using a single component hot film anemometer. Results from this study indicate the following: the flow in the recirculation region is almost perpendicular to the step, flow reattachment length decreases with increasing sweep angle, and in the reattachment region the velocity component parallel to the step face retains a finite magnitude. Coles' law of the wall and wake used to correlate the data from this study. The results indicate that upstream of the step, weak pressure gradients act on the flowfields, and downstream of reattachment of the flow recovers more rapidly as the sweep angle increases. A Baldwin-Lomax analysis on the separated profiles in the recirculation region suggest that all length scales must take into account the displacement of the shear layer from the wall. The correlation of the separated, normal and parallel, velocity profiles with the Baldwin-Lomax variables was fair. GRA

**N91-17318#** Princeton Univ., NJ. Dept. of Mechanical and Aerospace Engineering.
**NUMERICAL STUDIES OF THE STRUCTURE OF TURBULENT SHEAR FLOW Final Report, Jan. 1987 - Jan. 1990**
Steven A. Orszag Jul. 1990 11 p
(Contract F49620-87-C-0036)
(AD-A228747; AFOSR-90-1071TR) Avail: NTIS HC/MF A03
CSCL 20/4

Renormalization group methods (RNG) were applied to large eddy simulations of wall regions of channel flows and spectral element RNG simulations of flows in complex geometries were explored. The results predicted wall region streaks accurately at much less spatial resolution than earlier methods. The methods were extended to compressible flows. They were used to show that the shock region is characterized by large negative values of the divergence indicating tube-like structures. High enstrophy regions reside outside the shock regions. High vorticity regions in incompressible flow tend to be concentrated in tubes, while in compressible flows they tend to be concentrated in sheets. RNG was also applied to k-epsilon modelling of the flow over a backstep. Full simulations were also completed for large Reynolds number turbulence. GRA

**N91-17319#** Purdue Univ., West Lafayette, IN. School of Mechanical Engineering.
**EFFECTS OF FREE STREAM TURBULENCE ON HEAT TRANSFER Final Report, 1 Apr. 1987 - 31 Jul. 1990**
S. N. B. Murthy and P. Bradshaw (Stanford Univ., CA.) 28 Sep. 1990 93 p
(Contract F49620-87-K-0008; AF Proj. 2307)
(AD-A228920; AFW/M-B/90-1; AFOSR-90-1152TR) Avail: NTIS HC/MF A05 CSCL 20/4

Analytical-computational and experimental studies are presented on the determination of the influence of inhomogeneous and isotropic turbulence on boundary layers, including cases with heat transfer. The modelling of the influence of Free Stream Turbulence (FST) on boundary layer turbulence (BLT) has been based on the so-called large eddy interaction hypothesis, wherein the interaction between a representative large eddy and all of the eddies is related to a skewness factor and a damping factor. The boundary layer is divided into four asymptotically matched regions, including the free stream, and the flowfield is calculated based on the necessary (as proved herein) assumption of the existence of a logarithmic law region adjoining the wall viscous region. A detailed comparison between the experimental data Hancock and Bradshaw and the predictions obtained for the same case of interaction between FST and BLT in a fully developed TBL is presented and provides substantial credibility to the method of approach. Experimental work was devoted to a study of the effects of anisotropic FST on heat transfer in low speed TBL. GRA

**N91-17320*#** National Inst. of Standards and Technology, Boulder, CO. Chemical Engineering Science Div.
**HEAT TRANSFER IN A COMPACT TUBULAR HEAT EXCHANGER WITH HELIUM GAS AT 3.5 MPa**
Douglas A. Olson and Michael P. Glover Jun. 1990 66 p
Sponsored by NASA, Langley Research Center
(NASA-CR-187680; NAS 1.26:187680; PB91-107573; NISTIR-3941) Avail: NTIS HC/MF A04 CSCL 20D

A compact heat exchanger was constructed consisting of circular tubes in parallel brazed to a grooved base plate. This tube specimen heat exchanger was tested in an apparatus which radiatively heated the specimen on one side at a heat flux of up to 54 W/sq cm, and cooled the specimen with helium gas at 3.5 MPa and Reynolds numbers of 3000 to 35,000. The measured friction factor of the tube specimen was lower than that of a circular tube with fully developed turbulent flow, although the uncertainty was high due to entrance and exit losses. The measured Nusselt number, when modified to account for differences in fluid properties between the wall and the cooling fluid, agreed with past correlations for fully developed turbulent flow in circular tubes. Author

**N91-17321** Harvard Univ., Cambridge, MA.
**CAVITATION AND LOCALIZATION IN PLASTIC FLOW Ph.D. Thesis**
Yonggang Young Huang 1990 139 p
Avail: Univ. Microfilms Order No. DA9035483

Plastic flow localization occurs earlier in a material in which voids or void-nucleating particles (inclusions or second phase particles) are nonuniformly distributed, as opposed to uniformly distributed. The roles of clusters of voids and particles and general momentum defect distributions on flow localization are studied with emphasis on the loss of material ductility. The notion of a critical cluster is introduced which dominates the nonlinear flow localization for an arbitrary defect distribution. A scheme identifying the critical cluster and estimating material ductility for arbitrary particle distributions is proposed and verified. A continuum model is introduced to investigate the loss of material ductility due to a cluster of second phase particles, which can be considered as the critical cluster dominating flow localization for nonuniform particle distributions. The overall ductility depends strongly on the stress triaxiality level. At high triaxiality, a small cluster of particles or small deviation in local particle volume fractions can trigger early flow localization. At low triaxiality, the effect of clustering is only seen when the cluster size is over a critical value. The overall ductility also drops as the void nucleation rate increases. Plastic flow localization may occur immediately after the voids are nucleated, or following significant void growth. These two cases are called void nucleation-controlled and growth-controlled localization, respectively. In a high strength, low hardening solid, flow localization is usually nucleation-control. Other factors favoring void nucleation-controlled localization include: high stress triaxiality, large nonuniformity in the materials in the form of a large cluster of particles or large deviation in particle volume fraction, and a large rate of void nucleation. Dissert. Abstr.

**N91-17322** Georgia Inst. of Tech., Atlanta.
**AN ANALYSIS OF BODY FORCE EFFECTS ON TRANSIENT AND STEADY-STATE PERFORMANCE OF HEAT PIPES Ph.D. Thesis**
Walter Adrian Hendrix 1990 311 p
Avail: Univ. Microfilms Order No. DA9023814

The effect of body forces such as gravity fields and acceleration on the thermal performance of heat pipes is studied. Body forces primarily affect the movement of working fluid liquid in a heat pipe, and therefore, can influence the capillary, boiling, and entrainment heat transfer limits as well as the temperature and pressure distributions, conductance, and coupling of heat source to sink. Analytical models which predict the effect of body forces on the heat transfer limit of heat pipes were developed and shown to be capable of predicting experimental results taken from the literature. Dissert. Abstr.

**N91-17323** Exeter Univ. (England).
**THE USE OF CONFORMAL MAPPING FOR THE NUMERICAL SOLUTION OF SOME FLUID FLOW PROBLEMS Ph.D. Thesis**
Jeremy Duncan Manwar Linn 1989 177 p
Avail: Univ. Microfilms Order No. BRDX90641

A numerical model was developed to predict the low speed fluid flow in geometries with irregular boundaries. The model uses a pressure/velocity formulations of the Navier-Stokes equations. A grid generation procedure is used to generate numerically an orthogonal grid over the solution domain. Solutions to flow problems of importance in engineering are presented for two types of problems: the flow past circular cylinders placed transversely across the duct, and the flow in cylindrical mixing vessels. The conclusions are also drawn as to the value of the model, and its flexibility in coping with solution domains which have irregularly shaped boundaries. Dissert. Abstr.

**N91-17324** California Univ., Berkeley.
**DYNAMICS OF AXIALLY MOVING CONTINUA COUPLED TO VISCOUS FLUID LAYERS Ph.D. Thesis**
Chin An Tan 1989 154 p
Avail: Univ. Microfilms Order No. DA9006531

The dynamics of axially moving continua, such as moving tapes, band saws, and machine belts, coupled to viscous fluid layers are emphasized. The purposes are to understand how hydrodynamically induced bearing forces change the vibration of axially moving continua, and to predict the dynamic response and stability of the coupled system. The overall goal is to optimally design bearings for vibration control and stabilization of flexible continua. A systematic development of a model for the two-dimensional unsteady film flow under the forced transverse vibration of translating surface is presented. Linearized Navier-Stokes equations, including the unsteady fluid inertia, are obtained by assuming that both the surface displacement and the film Reynolds number are small. Three states of the model are defined: the unloaded, the equilibrium, and the dynamical states. The fluid model is then extended to study the dynamic interactions between two flexible surfaces and the flow of a viscous fluid film constrained between them. The equilibrium state is determined from solutions of an integral equation commonly found in elastohydrodynamic lubrication. A perturbation solution is developed and applied to an example where the flexible surfaces are elastic foundations. To illustrate the vibration coupling between two flexible surfaces through a viscous fluid layer, an idealized model is constructed employing the concept of the film dynamic

coefficient. The response problem for an axially moving continuum coupled to viscous fluid layers is formulated. The equations of motion are transformed to the Laplace domain, and an integral relation is obtained that governs the transverse displacement of the continuum. As an illustration of the proposed method, the vibration of a translating string, controlled through hydrodynamic bearing forces, is analyzed. Dissert. Abstr.

**N91-17325** Iowa State Univ. of Science and Technology, Ames.
**NUMERICAL SOLUTION OF THE STEADY, COMPRESSIBLE, NAVIER-STOKES EQUATIONS IN TWO AND THREE DIMENSIONS BY A COUPLED SPACE-MARCHING METHOD Ph.D. Thesis**
Peter Warren TenPas 1990 154 p
Avail: Univ. Microfilms Order No. DA9035119

An implicit, space-marching, finite-difference procedure is presented for solving the primitive variable form of the steady, compressible, Navier-Stokes equations in body-fitted, curvilinear coordinates. The numerical procedure uses the primitive variables of velocity and pressure and is suitable for simulating both incompressible and compressible flow. The algorithm employs multiple sweeps of the space-marching procedure to solve a coupled system of equations consisting of the Cartesian coordinate momentum equations and the continuity equation. A pressure correction method is described and is shown to significantly accelerate the convergence rate. The procedure is used to simulate incompressible and subsonic adiabatic flows over a broad range of Reynolds numbers in the laminar flow regime. Computed results are compared with other numerical predictions for the developing flow in two-dimensional and three-dimensional channel inlets, the separated flow in two-dimension channels with sudden expansions or contractions, and the crossflow over a cylinder. The method is shown to predict low Reynolds number flows more accurately than schemes based upon approximations of the Navier-Stokes equations. Results of initial studies to optimize the performance of the global pressure correction procedure are also presented and discussed. The new scheme is effective in rapidly propagating the downstream pressure boundary conditions throughout the flow field. Computed results for simulations of internal flows without large obstructions indicate that the convergence rate is not strongly dependent on the number of nodes. Dissert. Abstr.

**N91-17326** California Inst. of Tech., Pasadena.
**VORTEX SIMULATION OF SEPARATED FLOWS IN TWO AND THREE DIMENSIONS Ph.D. Thesis**
Kiat Chua 1990 231 p
Avail: Univ. Microfilms Order No. DA9031444

Applications of vortex methods to the problem of unsteady, separated flows in two and three dimensions are discussed. First, an improved method for satisfying the boundary conditions on a flat plate is developed and applied to the two-dimensional separated flow problem. Second, an improved three-dimensional vortex particle method is developed. In this method, vortex elements of vorticity that move with the local velocity and are stretched and rotated according to the local strain field are used. Lastly, the two-dimensional method developed in the first part is modified and extended to three dimensions. Here, solenoidal condition for vorticity is considered and closed vortex loops are used to represent the boundary layer vorticity and the vorticity at shedding. For the evolution of the vortex wake, the vortex particle method developed in the second part is used. Applications to the flow past a normal square plate are carried out and the early stages of the flow are studied. Dissert. Abstr.

**N91-17327** Toledo Univ., OH.
**NUMERICAL SIMULATION OF RAREFIED GAS FLOW THROUGH NOZZLES AND OVER SUBMERGED BODIES Ph.D. Thesis**
Chan-Hong Chung 1990 196 p
Avail: Univ. Microfilms Order No. DA9033404

A kinetic theory analysis is made of the rarefied gas flow through nozzles and over submerged bodies with arbitrary curvature. The Boltzmann integro-differential equation simplified by a model collision integral is written in two different coordinate systems, and solved by means of finite-difference approximation coupled with the discrete-ordinate method. For internal flow, a Cartesian coordinate system is employed. The physical space is transformed by a general grid-generation technique, and the velocity space is transformed to a polar coordinate system. For the case of external flow, an arbitrary orthogonal curvilinear coordinate system is used. Numerical codes are developed which can be applied to any complicated two-dimensional internal or external geometry for the flow regimes from free-molecular to slip. Predictions are made for the case of parallel slots and are compared with existing literature data. Results for the cases of convergent or divergent slots and two-dimensional nozzles with arbitrary contour at arbitrary Knudsen number are presented. Also, predictions are made for the external case of flow over a right circular cylinder in order to provide new results at transonic speed ranges where neither theoretical nor experimental data are available. The predicted drag on the cylinder is compared with existing literature data at low and high Mach numbers. For axisymmetric rarefied gas flow, the formulation is presented in which a cylindrical coordinate system with a general grid-generation technique is employed to treat both internal and external flows. Dissert. Abstr.

**N91-17328** Texas Univ., Austin.
**WAVENUMBER RESONANCE IN NONLINEAR WAVE INTERACTIONS IN THE WAKE OF A FLAT PLATE Ph.D. Thesis**
Jose Benigno DavilaAcaron 1990 160 p
Avail: Univ. Microfilms Order No. DA9031549

The spatial traits of nonlinear wave interactions in transitioning flow in the symmetric wake of a flat plate were studied. The study combines the use of hot wire anemometry and digital analysis techniques for extracting frequency and wavenumber information from velocity fluctuation time series measurements. The linear spatial coherence was computed from velocity fluctuation data in order to determine if the frequency modes behave as waves, that is, spatially coherent fluctuations with a well defined dispersion relation. A new method was used to compute the mode triad wavenumber mismatch. The results were used to determine to what extent wavenumber resonance is present among quadratically interacting frequency resonant modes, as predicted by resonant wave interaction theory. The results show that, in the early part of the transition, instability modes interact nonlinearity to generate spatially coherent modes at frequencies above the instability range. Quadratically interacting, frequency resonant mode triads involve the transfer of energy to the harmonics of the fundamental instability exhibit good wavenumber resonance, as predicted by resonant wave interaction theory. Dissert. Abstr.

**N91-17329** Purdue Univ., West Lafayette, IN.
**SECONDARY FLOW AND THREE-DIMENSIONAL SEPARATION IN CURVED CIRCULAR DUCTS Ph.D. Thesis**
Roger Edward Davis 1990 322 p
Avail: Univ. Microfilms Order No. DA9031311

Flows in singly curved bends and S-ducts of circular cross section were studied by means of flow visualization and detailed wall static pressure measurements. The emphasis was on developing flows with very short inlet tangents, although several cases were tested with fully developed pipe flow in the inlet tangent. The topology of the outer wall separation at entry to strongly curved pipe flow was documented by both visualization and pressure measurements. The secondary flow vortices were shown to be formed by two different mechanisms of separation on the inner wall of the bend. The existence of two different topologies for outer wall flow and of two different mechanisms for the formation of the secondary flow vortices are both examples of bifurcation in curved pipe flow. The parameter space is described for these bifurcations over the range of parameters studied. The pressure measurements show that the wall static pressure field is basically that of a free vortex centered at the center of curvature of the bend. A number of S-duct configurations were also tested. The

effect of the reversal of curvature on flow in the first bend was minimal except near the plane of inflection for most configurations. Dissert. Abstr.

**N91-17330** Pennsylvania State Univ., University Park.
**THE ELLIPTIC CALCULATION OF VISCOUS INCOMPRESSIBLE TURBOMACHINERY FLOWS Ph.D. Thesis**
Garth Victor Hobson 1990 212 p
Avail: Univ. Microfilms Order No. DA9032294

A new pressure based method was developed to solve the incompressible Navier-Stokes equations for turbomachinery flows. The new method solves for the pressure implicitly; no explicit correction is necessary within the iteration scheme. This new method was found to have better convergence than the pressure correction method. For two dimensional flows, the effects of turbulence are simulated by a low Reynolds number version of the two equation turbulence model. The validity of the turbulence model was extended by the prediction of two dimensional flow over a compressor blade profile. Turbine blade heat transfer was also computed and compared to experimental results. The three dimensional version of the code is validated with the prediction laminar internal flows. Finally, the complex three dimensional turbulent flow through a turbine end wall cascade was computed, and most physical phenomena were adequately resolved.
Dissert. Abstr.

**N91-17331** Colorado Univ., Boulder.
**NUMERICAL STUDY OF BOUNDARY LAYER INSTABILITY OF FLOW OVER AXISYMMETRIC CYLINDER Ph.D. Thesis**
Kai-Hsiung Kao 1990 132 p
Avail: Univ. Microfilms Order No. DA9032845

It was observed in the laboratory that the transition from laminar to turbulent flow in the boundary layer along a cylindrical body initiates in the form of two-dimensional Tollmien-Schlichting waves, followed by a region dominated by three-dimensional stretching of vortex lines that lead to the final breakdown of the flow into a chaotic state. Because of the variety of transitional behavior observed, it is clear that there are a number of possible paths leading to turbulence. Boundary layers on spinning and nonspinning bodies exhibit two modes of instability and transition which depends upon Reynolds number and spin rate. To study the onset of instability of the boundary layer along a semi-infinite circular cylinder, the incompressible laminar velocity field is computer numerically. A linear stability analysis of the boundary layer is then performed employing the Chebyshev collocation spectral method, which can be used to predict both the location at which the onset of instability occurs and the mode of the disturbance to be first excited. The work is extended further to consider a more realistic cylindrical body with a blunt nose, which generates an axial pressure gradient in the boundary layer. A numerical procedure is described for computing the stability of the boundary layer along a Rankine half-body generated by superposing a point source in a uniform flow. Boundary layer profiles and their neutral stability curves are obtained by the application of an implicit method and the Chebyshev collocation spectra method, respectively. From stability diagrams obtained for the cylinder with and without spin, the critical Reynolds number and the position on the cylinder at which onset of instability occurs can be determined. Dissert. Abstr.

**N91-17332** Tennessee Univ., Knoxville.
**A STUDY OF JETS IN CROSSFLOW AND ITS APPLICATION ON WINGTIP BLOWING Ph.D. Thesis**
Zhi Shi 1990 141 p
Avail: Univ. Microfilms Order No. DA9030735

The flowfield associated with jets in crossflow and their applications to the flowfield near the tip of a wing are studied both numerically and experimentally. The flowfields of different shaped jets oriented in crossflow were studied numerically. The predicted flow features generally agreed well with measurements and observations. Qualitatively, most of the basic flow physics were captured numerically, particularly for circular jet cases where data is available for comparisons. Periodic vortex formations were captured both at the front and the rear bound shear layers of the jet plume. The well known counter-rotating vortex pair is symmetric for a symmetrically oriented jet but is asymmetric for asymmetric jet. The source of these vortices is the jet-pipe boundary-layer vorticity. For any shaped jet, a pair of vertical twin tornado-like wake vortices would always form behind the jet plume due to the lower pressure at that region. These wake vortices are asymmetric in position and different on size for an asymmetrically placed jet. The source of these vortices is the crossflow boundary-layer vorticity. An experimental investigation of discrete wingtip jets was also conducted in both water and wind tunnels as an important application. Careful flow visualization revealed that the local perturbation introduced by the wingtip jet closely resembles that of asymmetric jets blowing from a flat plate. All types of vortices observed in the latter flowfield were identified in the flowfield generated by the wingtip jet. It was reconfirmed that the wingtip jets effectively dispersed the tip vortex and that the individual jet location and blowing momentum are the major parameters. Wing surface pressure measurements indicated that wingtip jets affected the global surface pressure distribution over the wing and improved its lift. Dissert. Abstr.

**N91-17333** Tennessee Univ., Knoxville.
**A SOLUTION OF THE EULER EQUATIONS ON AN UNSTRUCTURED GRID SYSTEM Ph.D. Thesis**
Michael Lee Stokes 1990 112 p
Avail: Univ. Microfilms Order No. DA9030741

A numerical algorithm is presented for the solution of the one and two-dimensional Euler Equations based on a conservative formulation. The objective of the study is to combine the theory of characteristics with a conservative finite volume algorithm, resulting in a numerical scheme with increased accuracy through the use of enhanced shock capturing capability and reduced levels of numerical dissipation. Characteristic boundary conditions are developed for subsonic and supersonic flow regimes and for solid wall boundaries. The numerical scheme is further broadened by the use of an unstructured triangular grid system with generalized placement of internal boundary conditions. The approach is to cast the Euler Equations in an uncoupled or approximately uncoupled form based on the classical eigenvalue study. Using the similarity transformation matrices from this study, a matrix operator is derived which splits a conservatively calculated residual into components which are propagated along specified paths. The matrix operator is derived for the quasi one-dimensional Euler Equations as well as the two-dimensional Euler Equations. Boundary conditions are derived based on a first order approximation of the compatibility equations for both the one and two-dimensional forms and shown to be consistent with the interior scheme. The numerical algorithm is validated by various test cases with comparisons to theory and other numerical flow solvers. The algorithm is shown to give near exact solutions for the one-dimensional steady state ducts with area variation. Salient features of the two-dimensional algorithm include excellent shock capturing capability, use of general unstructured grids for complex geometries, as well as the ability to accurately model low and high speed flows with little or no artificial dissipation required for stability. Dissert. Abstr.

**N91-17334** California Inst. of Tech., Pasadena.
**AN INVESTIGATION OF THE INVISCID SPATIAL INSTABILITY OF COMPRESSIBLE MIXING LAYERS Ph.D. Thesis**
Mei Zhuang 1990 142 p
Avail: Univ. Microfilms Order No. DA9031502

The behavior of both unbounded and bounded compressible plane mixing layers with respect to two- and three-dimensional, spatially growing wave disturbances is investigated using linear stability analysis. For unbounded mixing layers, the effects of the free stream Mach number, velocity ratio, temperature ratio, gas constant (molecular weight) ratio, and the ratios of specific heats on the linear spatial instability characteristics of a mixing layer are determined. A nearly universal dependence of the normalized maximum amplification rate on the convective Mach number is found for two-dimensional spatially growing disturbances, with the

normalized maximum amplification rate decreasing significantly with increasing convective Mach numbers in the subsonic region. The effect of parallel flow guide walls on a spatially growing mixing layer is also investigated. For supersonic convective Mach numbers, the maximum amplification rates of mixing layers approach an asymptotic value and this maximum amplification rate increases to a maximum value and decreases again as the distance between the walls decreases. Contour plots of the pressure perturbation fields of mixing layers indicate that there are waves propagating outward from the mixing layer along the Mach angle and that the walls provide a feedback mechanism between the growing mixing layer and this compression/expansion wave system. The bounded mixing layers are more unstable than the corresponding free mixing layers for supersonic convective Mach numbers. Dissert. Abstr.

**N91-17335** Exeter Univ. (England).
**HYDROELASTIC INSTABILITY OF FLEXIBLE SURFACES, VOLUMES 1 AND 2 Ph.D. Thesis**
Anthony Denis Lucey 1989 574 p
Avail: Univ. Microfilms Order No. BRDX90230

The stability of a finite compliant panel in a fluid flow is discussed. Throughout, unsteady potential flow is assumed and the compliant wall is represented by a flexible plate/spring model. The emphasis of the stability analysis rests upon divergence instability, although consideration is given to model-coalescence flutter and flexural responses that might support travelling wave flutter. Thin airfoil theory is used to generate the unsteady hydrodynamic pressures due to surface deflection comprising a collection of orthogonal modes. The system equations are cast into an eigenvalue problem after the use of Galerkin's method. A discussion of generalized hydrodynamic forces is given. Numerical methods are used to develop a working simulation of the interactive flow surface system. A boundary integral method generates the flow solution, the resulting hydrodynamic pressures being used to drive a finite difference formulation of the surface mechanics. Thus, the evolution of a disturbance may be followed as time passes after a perturbation from equilibrium. In summary, suitable methods are presented for easily predicting critical flow speeds and providing some insight into the disturbance forms that might be taken by the hydroelastic response of a finite compliant panel.
Dissert. Abstr.

**N91-17336** Georgia Inst. of Tech., Atlanta.
**COHERENT AND RANDOM APPARENT STRESSES IN PERIODICALLY UNSTEADY FLOWS Ph.D. Thesis**
Anthony Byrd Kehoe 1990 247 p
Avail: Univ. Microfilms Order No. DA9031266

The transitional flow field downstream of a smooth, symmetrically constricted Sylgard pipe was measured with a two color, two component Laser Doppler Anemometer for both pulsatile and steady flows. Vibrations in the flow system were induced with an exciter/shaker and were monitored with an accelerator. The vibration has little effect on the value of the maximum axial and radial turbulence intensities. A frequency domain signal processing technique to separate the disturbance velocity into coherent and random components was modified to guarantee that the sum of the decomposed velocity components equaled the original disturbance velocity. Results of the velocity separation demonstrated that the velocity disturbances prior to turbulent transition consisted almost entirely of coherent velocity fluctuations. The maximum apparent shear stress was found to occur just after the turbulent transition and consisted almost entirely of the random component. The data suggest that if the absolute magnitude of the apparent stress is the determining factor in red blood cell destruction, then the coherent apparent stress is not a significant destruction mechanism. However, the exact mechanism in hemolysis are not identified. Dissert. Abstr.

**N91-17337** California Univ., Irvine.
**ACOUSTIC OSCILLATIONS IN DUMP COMBUSTOR CONFIGURATIONS Ph.D. Thesis**
Kamyar Molavi 1990 336 p
Avail: Univ. Microfilms Order No. DA9030040

A computational method is devised to simulate the flow field in dump combustors. In coaxial dump combustors, the flow field is primarily axisymmetric and can be analytically simulated by solving the unsteady, axisymmetric Navier-Stokes equations. In this configuration, the mixing between the fuel and the oxidizer depends on the recirculation zone created by the sudden expansion of the inlet duct. The flow field in a dump combustor is a complex fluid mechanical combination of turbulent fuel-air mixing, flow separation, flow recirculation, shear flow attachment, and acoustic coupling. The present numerical model considers single component fuel using an advanced transient drop vaporization scheme. The liquid-phase equations describe the drop trajectory, velocity, temperature, and vaporization rate. A second order method is used to solve these equations. The interaction between the acoustics and the combusting flow field are studied. Cases of practical importance are studied by simulating the low Mach number flow inside the combustor. The short nozzle approximation is considered at the exit of the combustor. Results indicate that turbulent mixing is prevalent over most of the combustor.
Dissert. Abstr.

**N91-17338** Pennsylvania State Univ., University Park.
**TURBULENCE CHARACTERISTICS AND BUBBLE DYNAMICS OF A MICROBUBBLE-MODIFIED BOUNDARY LAYER Ph.D Thesis**
Sibtosh Pal 1990 256 p
Avail: Univ. Microfilms Order No. DA9032357

The effects of injecting microbubbles into a zero-pressure gradient turbulent boundary layer on the shear stress are experimentally investigated. Microbubbles are injected by pumping air through a porous section. The resulting microbubble cloud and its effect on the skin friction is surveyed by an array of flush-mounted hot film probes. The shear stress signals measured by the hot film probes are investigated and results in the form of power spectra and probability density functions and their associated moments are presented. The location and trajectory of the bubble cloud and the bubble diameters representative of such clouds were measured by a laser attenuation technique and photographic surveys, respectively, and these results are presented.
Dissert. Abstr.

**N91-17339#** Royal Aerospace Establishment, Farnborough (England).
**LOCAL SOLUTION FOR THE FLOW OF AN IDEAL FLUID NEAR A SEPARATION LINE**
V. A. Malanichev and J. H. B. Smith, ed. Jan. 1990 14 p Transl. into ENGLISH from Uchenye Zapiski TsAGI (USSR), v. 17, no. 4, 1986 p 8-15 Original language document was announced in IAA as A88-50054
(RAE-TRANS-2181; BR115577) Avail: NTIS HC/MF A03

Three-dimensional flows with a surface having tangential velocity separation are examined. A general method is proposed for solving local problems near a separation line, and three concrete examples were considered. The solution which were obtained are of interest for the numerical calculation of the evolution of a vortex sheet. For the first time the possibility was indicated of breaching the '3/2' law during separation of flow from a wedge-shaped edge. Author

**N91-17340*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
**HIGH VELOCITY GAS PARTICULATE SAMPLING SYSTEM Patent Application**
Wallace C. Tuthill, inventor (to NASA) 11 Dec. 1990 12 p
(NASA-CASE-MSC-21729-1; NAS 1.71:MSC-21729-1; US-PATENT-APPL-SN-625344) Avail: NTIS HC/MF A03 CSCL 20D

A gas sampling system is disclosed for determining particulate matter contamination in a high velocity gas flow where the sampling chamber is first cleaned, then evacuated and is coupled by a closed three way valve in a straight line relationship to the gas supply line. A predetermined gas flow rate is established through the three way valve which is quickly opened to couple the

dynamically flow gas to the evacuated sample chamber in a straight line relationship to trap a gas sample under dynamic conditions. When the sampling chamber has a gas sample the three way valve is again closed so that particulate matter in the sample chamber can be flushed from the sample chamber with a compatible liquid to a filter for collection and analysis. NASA

**N91-17341*#** Case Western Reserve Univ., Cleveland, OH.
**EXPERIMENTAL STUDY OF BOUNDARY LAYER TRANSITION WITH ELEVATED FREESTREAM TURBULENCE ON A HEATED FLAT PLATE Final Report**
Ki-Hyeon Sohn and Eli Reshotko Feb. 1991 266 p
(Grant NAG3-230)
(NASA-CR-187068; NAS 1.26:187068) Avail: NTIS HC/MF A01 CSCL 20D

A detailed investigation to document momentum and thermal development of boundary layers undergoing natural transition on a heated flat plate was performed. Experimental results of both overall and conditionally sampled characteristics of laminar, transitional, and low Reynolds number turbulent boundary layers are presented. Measurements were acquired in a low-speed, closed-loop wind tunnel with a freestream velocity of 100 ft/s and zero pressure gradient over a range of freestream turbulence intensities (TI) from 0.4 to 6 percent. The distributions of skin friction, heat transfer rate and Reynolds shear stress were all consistent with previously published data. Reynolds analogy factors for R(sub theta) is less than 2300 were found to be well predicted by laminar and turbulent correlations which accounted for an unheated starting length. The measured laminar value of Reynolds analogy factor was as much as 53 percent higher than the Pr(sup -2/3). A small dependence of turbulent results on TI was observed. Conditional sampling performed in the transitional boundary layer indicated the existence of a near-wall drop in intermittency, pronounced at certain low intermittencies, which is consistent with the cross-sectional shape of turbulent spots observed by others. Non-turbulent intervals were observed to possess large magnitudes of near-wall unsteadiness and turbulent intervals had peak values as much as 50 percent higher than were measured at fully turbulent stations. Non-turbulent and turbulent profiles in transitional boundary layers cannot be simply treated as Blasius and fully turbulent profiles, respectively. The boundary layer spectra indicate predicted selective amplification of T-S waves for TI is approximately 0.4 percent. However, for TI is approximately 0.8 and 1.1 percent, T-S waves are localized very near the wall and do not play a dominant role in transition process. Author

**N91-17342*#** David Sarnoff Research Center, Princeton
**LINEAR LASER DIODE ARRAYS FOR IMPROVEMENT OPTICAL DISK RECORDING Final Report, 2 Sep. . Jun. 1990**
G. A. Alphonse, D. B. Carlin, and J. C. Connolly Dec. 1990 52 p
(Contract NAS1-18226)
(NASA-CR-182098; NAS 1.26:182098) Avail: NTIS HC/MF A04 CSCL 20D

The development of individually addressable laser diode arrays for multitrack magneto-optic recorders for space stations is discussed. Three multi-element channeled substrate planar (CSP) arrays with output power greater than 30 mW with linear light vs current characteristics and stable single mode spectra were delivered to NASA. These devices have been used to demonstrate for the first time the simultaneous recording of eight data tracks on a 14-inch magneto-optic erasable disk. The yield of these devices is low, mainly due to non-uniformities inherent to the LPE growth that was used to fabricate them. The authors have recently developed the inverted CSP, based on the much more uniform MOCVD growth techniques, and have made low threshold quantum well arrays requiring about three times less current than the CSP to deliver 30 mW CW in a single spatial mode. The inverted CSP is very promising for use in space flight recorder applications. Author

**N91-17343#** Maryland Univ., College Park. Dept. of Aerospace Engineering.
**NON-EQUILIBRIUM CHEMISTRY EFFECTS ON HYPERSONIC SEPARATED FLOWS: SHOCK-WAVE/BOUNDARY-LAYER INTERACTION Final Report, 1 Mar. 1988 - 28 Feb. 1990**
John D. Anderson, Jr. 27 Sep. 1990 47 p Presented at the 29th AIAA Aerospace Sciences Meeting, Reno, NV, Jan. 1991
(Grant AF-AFOSR-0107-88; AF Proj. 2307)
(AD-A229015; AFOSR-90-1134TR) Avail: NTIS HC/MF A03 CSCL 20/4

The effect of nonequilibrium chemical reactions on separated hypersonic flow is investigated. The model used to generate the separated flow is a hypersonic shock wave/boundary layer interaction on a flat plate in a high enthalpy flow. The flow was calculated by means of a finite-difference, time-marching solution. The results show that nonequilibrium effects can be important in the separated flow region, and that future applications should be aware of such effects. GRA

**N91-17344#** Northwestern Univ., Evanston, IL. Dept. of Engineering Science and Applied Mathematics.
**THE STABILITY AND DYNAMICS OF ELASTIC STRUCTURES AND FLUID FLOWS Final Report, 1 Feb. 1985 - 28 Feb. 1990**
Edward L. Reiss Sep. 1990 24 p
(Grant AF-AFOSR-0150-85; AF Proj. 2304)
(AD-A229047; AFOSR-90-1133TR) Avail: NTIS HC/MF A03 CSCL 20/4

The main thrust of our research program has been the development and applications of asymptotic and perturbation methods for analyzing the stability and dynamics of elastic structures, fluid flow, and other nonlinear problems, and for problems of scattering of acoustic, electromagnetic and other waves. GRA

**N91-17345#** Brookhaven National Lab., Upton, NY. Reactor Div.
**COUNTER-CURRENT FLOW LIMITED CHF IN THIN RECTANGULAR CHANNELS**
Lap Y. Cheng 1990 8 p Presented at the 13th ASME-JSME International Solar Energy Conference, Reno, NV, 17-22 Mar. 1991
(Contract DE-AC02-76CH-00016)
(DE91-004755; BNL-45355; CONF-910318-10) Avail: NTIS HC/MF A02

An analytical expression for counter current flow limitation (CCFL) was used to predict critical heat flux (CHF) for downward flow in thin vertical rectangular channels which are prototypes of coolant channels in test and research nuclear reactors. Top flooding is the mechanism for counter-current flow limited CHF. The CCFL correlation also was used to determine the circulation and flooding-limited CHF. Good agreements were observed between the period the model predictions and data on the CHF for downflow. The minimum CHF for downflow is lower than the flooding-limited CHF and it is predicted to occur at a liquid flow rate higher than that at the flooding limit. DOE

**N91-17346#** Ohio State Univ., Columbus. Dept. of Physics.
**TURBULENCE AND SPATIO-TEMPORAL CHAOS**
1990 11 p
(Contract DE-FG02-88ER-13916)
(DE91-006159; DOE/ER-13916/2) Avail: NTIS HC/MF A03

Abstracts are presented on the following topics: Saffman-Taylor instability; cylinder wake; Levy walk and turbulent channel flow; bubble motion and bubble streams; spinal turbulent and wetting; collective behavior of a coupled map system with a conserved quantity; and stability of temporally periodic states. Other topics covered include: generic nonergodic behavior in continuous systems; characterization of unstable periodic orbits in low-dimensional chaotic attractors and repellers; and Ginzburg-Landau theory for oil-water-surfactant mixture. DOE

**N91-17127*#** Aerojet TechSystems Co., Sacramento, CA.
**DEVELOPMENT OF A COMBUSTOR ANALYTICAL DESIGN METHODOLOGY FOR LIQUID ROCKET ENGINES**
Jerry L. Pieper and Jeff Muss *In* Johns Hopkins Univ., The 26th JANNAF Combustion Meeting, Volume 2 Oct. 1989 p 223-231 (For primary document see N91-17125 09-20)
(Contract NAS3-25556)
Avail: NTIS HC/MF A18 CSCL 20D

**N91-17128*#** CFD Research Corp., Huntsville, AL.
**ASSESSMENT OF NUMERICAL METHODS FOR THE SOLUTION OF FLUID DYNAMICS EQUATIONS FOR NONLINEAR RESONANCE SYSTEMS**
A. J. Przekwas and H. Q. Yang *In* Johns Hopkins Univ., The 26th JANNAF Combustion Meeting, Volume 2 Oct. 1989 p 233-242 Sponsored by NASA, Marshall Space Flight Center (For primary document see N91-17125 09-20)
Avail: NTIS HC/MF A18 CSCL 21H

**N91-17130*#** National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
**FURTHER IMPROVEMENTS TO NOZZLE BOUNDARY LAYER CALCULATIONS IN BLIMPJ**
S. C. Praharaj (Remtech, Inc., Huntsville, AL.) and Klaus W. Gross *In* Johns Hopkins Univ., The 26th JANNAF Combustion Meeting, Volume 2 Oct. 1989 p 311-325 (For primary document see N91-17125 09-20)
Avail: NTIS HC/MF A18 CSCL 20D

**N91-17131*#** National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
**LIQUID BEHAVIOR AT CRITICAL AND SUPERCRITICAL CONDITIONS**
Huei-huang Chiu (Illinois Univ., Chicago.) and Klaus W. Gross *In* Johns Hopkins Univ., The 26th JANNAF Combustion Meeting, Volume 2 Oct. 1989 p 335-342 (For primary document see N91-17125 09-20)
Avail: NTIS HC/MF A18 CSCL 21H

# 35 INSTRUMENTATION AND PHOTOGRAPHY

Includes remote sensors; measuring instruments and gages; detectors; cameras and photographic supplies; and holography.

For aerial photography see *43 Earth Resources and Remote Sensing*. For related information see also *06 Aircraft Instrumentation*, and *19 Spacecraft Instrumentation*.

**N91-17347#** Maryland Univ., College Park. Lab. for Plasma Research.
**A 30 MW, 10 GHz GYROKLYSTRON WITH LINEAR COLLIDER APPLICATION**
W. Lawson, P. E. Latham, J. Calame, M. Skopec, D. Welsh, B. Hogan, M. Maiman, M. E. Read, C. D. Striffler, and M. Reiser 1989 16 p Presented at the Workshop on Advanced Accelerator Concepts, Lake Arrowhead, CA, 9-13 Jan. 1989
(Contract DE-AC05-85ER-40216)
(DE90-009991; CONF-890197-13) Avail: NTIS HC/MF A03

The final preparations for bringing the University of Maryland's 10 GHz, 30 MW gyroklystron experiment on-line are discussed. The initial operation of the modulator and the acceptance tests performed on the electron gun are described. The enhanced circuit modeling is explained and a two-cavity design is presented which predicts an efficiency of 33 percent and a gain of 27 dB. The realization of the design is also discussed. In addition, the output waveguide and the diagnostics are briefly discussed for beam and RF characterization. Finally, a four-cavity circuit design is presented with its predicted operating parameters that can achieve the necessary gain and efficiency required for accelerator application. DOE

**N91-17348#** Illinois Univ., Chicago. Dept. of Mechanical Engineering.
**A DOUBLE WAVELENGTH INTERFEROMETER FOR THE STUDY OF HEAT AND MASS TRANSFER IN DOUBLE DIFFUSIVE SYSTEMS**
Weimin Lu and William M. Worek 1990 84 p
(Contract DE-AC02-84ER-13152)
(DE90-011431; DOE/ER-13152/T3) Avail: NTIS HC/MF A05

An experimental test system capable of measuring the variation of the refractive index of a salt water solution with spatially varying temperature and concentration were performed using two-wavelength Mach-Zehnder interferometer. An experimental data reduction method and computing program were developed to take the data generated in the tests and to determine the variation of the refractive index with temperature and concentration at two different wavelengths. The experimental data obtained from the test system was reduced and curve fitted by a nonlinear regression algorithm numerical method to determine the functional dependence of the refractive index on temperature and concentration. A numerical study was conducted using these results in a system to determine the fringe shift due to temperature and concentration at two wavelengths. Two wavelength interferograms were generated, and using this information the temperature and concentration distribution from two wavelength interferograms were inferred. A double diffusion experimental test system also was designed to reproduce the case simulated. DOE

**N91-17349*#** California Univ., Los Angeles. Dept. of Mechanical, Aerospace and Nuclear Engineering.
**THE USE OF HOLOGRAPHIC INTERFEROMETRY FOR MEASUREMENTS OF TEMPERATURE IN A RECTANGULAR HEAT PIPE M.S. Thesis**
Jure Marn 1989 58 p
(Contract NCC2-374; NAG3-899)
(NASA-CR-187424; NAS 1.26:187424) Avail: NTIS HC/MF A04 CSCL 20F

Holographic interferometry is a nonintrusive method and as such possesses considerable advantages such as not disturbing the velocity and temperature field by creating obstacles which would alter the flow field. These optical methods have disadvantages as well. Holography, as one of the interferometry methods, retains the accuracy of older methods, and at the same time eliminates the system error of participating components. The holographic interferometry consists of comparing the objective beam with the reference beam and observing the difference in lengths of optical paths, which can be observed during the propagation of the light through a medium with locally varying refractive index. Thus, change in refractive index can be observed as a family of nonintersecting surfaces in space (wave fronts). The object of the investigation was a rectangular heat pipe. The goal was to measure temperatures in the heat pipe, which yields data for computer code or model assessment. The results were obtained by calculating the temperatures by means of finite fringes. Author

**N91-17350*** National Aeronautics and Space Administration. Pasadena Office, CA.
**TORQUE SENSOR HAVING A SPOKED SENSOR ELEMENT SUPPORT STRUCTURE Patent**
Boris J. Lurie, inventor (to NASA) and J. Alan Schier, inventor (to NASA) (Jet Propulsion Lab., California Inst. of Tech., Pasadena.) 12 Jun. 1990 8 p Filed 21 Mar. 1989
(NASA-CASE-NPO-17461-1-CU; US-PATENT-4,932,270; US-PATENT-APPL-SN-326820; US-PATENT-CLASS-73-862.33; US-PATENT-CLASS-73-862.36; INT-PATENT-CLASS-G01L-3/00)
Avail: US Patent and Trademark Office CSCL 14B

Piezoelectric sensor devices are attached across pairs of circularly arranged spokes arrayed on the periphery of an annular ring. The sensor devices each include a preloaded steel ball mounting arrangement for mounting a piezoelectric sensor element. A first circular interface plate on one side of the sensor structure attaches to alternate one of the spokes, and a circular interface

plate on the opposite side of the same diameter as the first interface plate attaches to the remaining spokes.
Official Gazette of the U.S. Patent and Trademark Office

**N91-17351*#** Lockheed Missiles and Space Co., Huntsville, AL. Engineering Center.
**LASER ATMOSPHERIC WIND SOUNDER (LAWS) PHASE 1. VOLUME 1: EXECUTIVE SUMMARY Final Report, 24 Mar. 1989 - 23 Mar. 1990**
Apr. 1990 71 p
(Contract NAS8-37590)
(NASA-CR-184068; NAS 1.26:184068;
LMSC-HSV-TR-F312203-VOL-1) Avail: NTIS HC/MF A04
CSCL 14B

The laser atmospheric wind sounder (LAWS) will provide a new space based capability for the direct measurement of atmospheric winds in the troposphere. LAWS will make a major contribution toward advancing the understanding and prediction of the total Earth system and NASA's Earth Observing System (EOS) Program. LAWS is designed to measure a fundamental atmospheric parameter required to advance weather forecasting accuracies and investigate global climatic change. LAWS has a potential added benefit of providing (global) concentration profiles of large aerosols including visible and subvisible cirrus clouds, volcanic dust, smoke, and other pollutants. The objective of this Phase One study was to develop a LAWS concept and configuration. The instrument design is outlined in this first volume of three. Author

**N91-17352*#** Lockheed Missiles and Space Co., Huntsville, AL. Engineering Center.
**LASER ATMOSPHERIC WIND SOUNDER (LAWS) PHASE 1. VOLUME 2 Final Report, 24 Mar. 1989 - 23 Mar. 1990**
Apr. 1990 297 p
(Contract NAS8-37590)
(NASA-CR-184069; NAS 1.26:184069;
LMSC-HSV-TR-F312203-VOL-2) Avail: NTIS HC/MF A13
CSCL 14B

This report summarizes and documents the results of the 12-month phase 1 work effort. The objective of phase 1 was to establish the conceptional definition of the laser atmospheric wind sounder (LAWS) sensor system, including accommodations analyses to ensure compatibility with the Space Station Freedom (SSF) and the Earth Observing System (EOS) Polar Orbiting Platform (POP). Various concepts were investigated with trade studies performed to select the configuration to be carried forward to the phase 2 Preliminary Design Definition. A summary of the LAWS system and subsystem trade studies that were performed leading to the baseline design configuration is presented in the appendix. The overall objective of the LAWS Project is to define, design, and implement an operational space based facility, LAWS, for accurate measurement of Earth wind profiles. Phase 1 addressed three major areas: (1) requirements definition; (2) instrument concepts and configurations; and (3) performance analysis. For the LAWS instrument concepts and configurations, the issues which press the technological state of the art are reliable detector lifetime and laser performance and lifetime. Lag angle compensation, pointing accuracy, satellite navigation, and telescope design are significant technical issues, but they are considered to be currently state of the art. The primary issues for performance analysis concern interaction with the atmosphere in terms of backscatter and attenuation, wind variance, and cloud blockage. The phase 1 tasks were formulated to address these significant technical issues and demonstrate the technical feasibility of the LAWS concept. Primary emphasis was placed on analysis/trade and identification of candidate concepts. Promising configurations were evaluated for performance, sensitivities, risks, and budgetary costs. Lockheed's baseline LAWS configuration is presented. Author

**N91-17353*#** Lockheed Missiles and Space Co., Huntsville, AL. Engineering Center.
**LASER ATMOSPHERIC WIND SOUNDER (LAWS) PHASE 1. VOLUME 3: PROJECT COST ESTIMATES Final Report, 24 Mar. 1989 - 23 Mar. 1990**
Apr. 1990 39 p
(Contract NAS8-37590)
(NASA-CR-184070; NAS 1.26:184070;
LMSC-HSV-TR-F312203-VOL-3) Avail: NTIS HC/MF A03
CSCL 14B

The laser atmospheric wind sounder (LAWS) cost modeling activities were initiated in phase 1 to establish the ground rules and cost model that would apply to both phase 1 and phase 2 cost analyses. The primary emphasis in phase 1 was development of a cost model for a LAWS instrument for the Japanese Polar Orbiting Platform (JPOP). However, the Space Station application was also addressed in this model, and elements were included, where necessary, to account for Space Station unique items. The cost model presented in the following sections defines the framework for all LAWS cost modeling. The model is consistent with currently available detail, and can be extended to account for greater detail as the project definition progresses. Author

**N91-17354#** Electronics Research Lab., Adelaide (Australia).
**ANALYSIS OF EMISSION DATA FROM A BROAD-BAND RADIOMETER**
Soi-Sang Ti, Adrian Tudini, and Ray Oermann Jun. 1990 18 p
(AD-A228912; ERL-0523-RR; DODA-AR-006-425) Avail: NTIS HC/MF A03 CSCL 14/2

The principles of analysis of emission data from a broadband radiometer are outlined. The errors arising from the analysis are also discussed and illustrated. In general, in the determination of radiant output of an emitter using a broadband radiometer, errors unknown magnitude will occur unless the spectral emission profile of the calibration source is matched to that of the emitter. GRA

**N91-17355#** California Univ., Berkeley. Materials and Chemical Sciences Div.
**FABRICATION OF AN INFRARED BOLOMETER WITH A HIGH Tc SUPERCONDUCTING THERMOMETER**
S. Vergjese, Paul L. Richards, K. Char, and S. A. Sachtjen (Conductus, Inc., Sunnyvale, CA.) Sep. 1990 7 p Presented at the Applied Superconductivity Conference, Aspen, CO, 24-28 Sep. 1990 Submitted for publication
(Contract DE-AC03-76SF-00098)
(DE91-005210; LBL-28989; CONF-900944-23) Avail: NTIS HC/MF A02

A sensitive high (Tc) superconducting bolometer was fabricated on a 20 micron thick sapphire substrate with a YBCO thin film transition edge thermometer. Optical measurements with a He-Ne laser gave a noise equivalent power of 2.4 x 10(exp -11) W/Hz(exp 1/2) at 10 Hz and a responsivity of 17 V/W in good agreement with electrical bolometer measurements. Gold black smoke was then deposited on the back side of the assembled bolometer as an absorber. Spectral measurements on a Fourier transform spectrometer show that the bolometer has useful sensitivity from visible wavelengths to beyond approx. 100 microns. This performance is clearly superior to that of a commercial room temperature pyroelectric detector. Some improvement appears possible. DOE

**N91-17356#** Lawrence Livermore National Lab., CA.
**TIMING BETWEEN STREAK CAMERAS WITH A PRECISION OF 10 ps**
R. A. Lerche Dec. 1990 8 p Presented at the 34th SPIE Annual International Technical Symposium on Optical and Optoelectronic Applied Science and Engineering, San Diego, CA 8-13 Jul. 1990
(Contract W-7405-eng-48)
(DE91-005266; UCRL-JC-104877; CONF-900756-55) Avail: NTIS HC/MF A02

The laser beams irradiating a target at the Nova laser facility comprise a set of ten simultaneous events. Two streak cameras,

whose resolutions are 40 ps, record the power history for each beam, five beams to a camera; their time bases are cross-timed with a fiducial pulse. Analysis of data recorded for target experiments conducted over a six month period shows the precision for cross-timing signals between two streak cameras to be plus or minus 9 ps and for characterizing a single temporal feature of a pulse to be plus or minus 5 ps. Beam synchronization at the end of six months was within 20 ps of the synchronization at the beginning of the experiments. A beam timing shift greater than 25 ps can be detected on a single laser shot; shifts of 10 to 20 ps require several shots to detect. DOE

**N91-17357** Deutsche Geodaetische Kommission, Munich (Germany, F.R.).
**USE OF CCD CAMERAS FOR THE DIFFERENTIAL RESTITUTION OF PHOTOGRAMMETRIC SNAPSHOTS Ph.D. Thesis - Karlsruhe Univ. [EINSATZ VON CCD-KAMERAS ZUR DIFFERENTIELLEN ENTZERRUNG PHOTOGRAMMETRISCHER AUFNAHMEN]**
Franz-Josef Behr 1989 115 p In GERMAN
(SER-C-356; ISBN-3-7696-9404-X; ISSN-0065-5325; ETN-91-98640) Copyright Avail: Deutsche Geodaetische Kommission, D-8000 Munich 22, Marstallplatz 8, Postfach 220 002, Fed. Republic of Germany

The use of Charged Coupled Device (CCD) cameras for the fabrication of orthophotos is described. The integrated use of optical electronic system components is identified as hybrid orthophoto production. The video equipment allows the hybrid orthophoto production. The radiometric and geometrical system properties are to be considered for the design of the hybrid orthophoto system, in order to obtain a high quality product. The system is based on a photoprocessing base package which allows an efficient software development as well as control and further handling (radiometric adjustment, contour generation). A series of examples of the differential restitution of individual objects, such as bridges or large surface buildings is presented. It is shown that, using appropriate software, an analytical plotter equipped with a valuable standardized photoprocessing hardware can be used as an orthophoto projector. ESA

**N91-17358#** Holometrix, Inc., Cambridge, MA.
**HOLOGRAPHIC OPTICAL HEAD Final Technical Report, Aug. 1988 - May 1990**
P. Gregory DeBaryshe, Charles S. Ih, and B. Zheng (Delaware Univ., Newark.) Sep. 1990 34 p
(Contract F30602-88-C-0124)
(AD-A229192; RADC-TR-90-200) Avail: NTIS HC/MF A03 CSCL 14/1

An experimental optical head using Holographic Optical Elements (HOEs) has been set up in our laboratory. The observed reconstructed spot size is less than 2 micron in diameter. Wavelength tolerance is +/-5nm centered at 832 nm. A new design using two aspherical lenses and two HOEs would operate over +/-15 nm. The new design can be the basis of a practical, highly compact, and reliable optical head. Performance can be significantly enhanced by using an e-beam pattern generator to fabricate an intermediate computer generated hologram needed to process the working HOEs. This will simplify the fabrication procedure and greatly reduce fabrication errors. Significant progress has also been made in developing a technique to make high-efficiency volume IR holograms, whose diffraction efficiency may approach 100 percent. This technique is unique and has not been reported in the literature by other researchers. Continuing effort is recommended to use an e-beam pattern generator to fabricate the intermediate HOEs, to design and fabricate high efficiency. GRA

# 36 LASERS AND MASERS

Includes parametric amplifiers.
For related information see also *76 Solid-State Physics.*

**N91-17359#** Defense Intelligence Agency, Washington, DC. Directorate for Scientific and Technical Intelligence.
**BIBLIOGRAPHY OF SOVIET LASER DEVELOPMENTS, MARCH-APRIL 1988**
Mar. 1990 110 p
(AD-A227788; DIA-DST-2700Z-002-90) Avail: NTIS HC/MF A06 CSCL 09/3

This is the Soviet Laser Bibliography for March to April 1988. The coverage includes basic research on solid state, liquid, gas, and chemical lasers; components; nonlinear; optics; spectroscopy of laser materials; ultrashort pulse generation; theoretical aspects of advanced lasers; and general laser theory. Laser applications are listed under biological effects; communications systems; beam propagation; adaptive optics; computer technology; holography, laser-induced chemical reactions; measurement of laser parameters; laser measurement applications; laser-excited optical effects; laser spectroscopy; beam-target interaction; and plasma generation and diagnostics. GRA

**N91-17360*#** National Aeronautics and Space Administration. Pasadena Office, CA.
**CLADDING FOR TRANSVERSE-PUMPED SOLID-STATE LASER Patent**
Robert L. Byer, inventor (to NASA) and Tso Y. Fan, inventor (to NASA) (Jet Propulsion Lab., California Inst. of Tech., Pasadena.) 22 Aug. 1989 7 p Filed 12 Dec. 1988
(NASA-CASE-NPO-17355-1-CU; US-PATENT-4,860,295; US-PATENT-APPL-SN-283431; US-PATENT-CLASS-372-19; US-PATENT-CLASS-372-39; US-PATENT-CLASS-372-66; US-PATENT-CLASS-372-70; INT-PATENT-CLASS-H01S-3/098)
Avail: US Patent and Trademark Office CSCL 20E

In a transverse pumped, solid state laser, a nonabsorptive cladding surrounds a gain medium. A single tranverse mode, namely the Transverse Electromagnetic (TEM) sub 00 mode, is provided. The TEM sub 00 model has a cross sectional diameter greater than a transverse dimension of the gain medium but less than a transverse dimension of the cladding. The required size of the gain medium is minimized while a threshold for laser output is lowered.

Official Gazette of the U.S. Patent and Trademark Office

**N91-17361#** Ortel Corp., Alhambra, CA.
**VERTICAL EMITTING, RING GEOMETRY, ULTRA-LOW THRESHOLD, AND ULTRA-HIGH SPEED QUANTUM WELL LASERS FOR OPTICAL INTERCONNECT Status Report No. 6, Jun. - Sep. 1990**
Michael Mittelstein and Nadav Bar-Chaim Sep. 1990 9 p
(Contract N00014-88-C-0483; DARPA Order 6325)
(AD-A228421) Avail: NTIS HC/MF A02 CSCL 09/3

Emphasis was placed on the following efforts: design and implementation of a test station for vertical emitting lasers; ridge waveguide structure and ring configuration lasers; refinement of grating fabrication for repeatability; and single quantum well material investigation. GRA

**N91-17362#** United Technologies Research Center, East Hartford, CT.
**TURNABLE BLUE-GREEN LIDAR TRANSMITTER DEMONSTRATION: INJECTION LASER TECHNOLOGY Final Report, 15 May 1987 - 30 Aug. 1990**
W. L. Nighan, R. A. Rubino, A. J. Cantor, and W. H. Glenn 30 Aug. 1990 163 p
(Contract N00014-87-C-0371)
(AD-A228425; UTRC-R90-927764) Avail: NTIS HC/MF A08 CSCL 09/3

In collaboration with Rice University, a scaling demonstration was made of the tunable, blue-green XeF(C-A) excimer laser focusing on the general requirements of a sensor for optical discrimination applications. Under separate contract Rice

developed a scaled, repetitively pulsed XeF(C-A) laser amplifier. While under the present contract UTRC developed a wavelength agile dye laser as a source of injection control for the Rice amplifier. In late 1989 the UTRC injection laser was successfully integrated with the Rice XeF(C-A) amplifier, resulting in wavelength agile XeF(C-A) laser operation at the 1 J/pulse level, combined with an intrinsic efficiency greater than 1 percent and a pulse repetition rate of 1 Hz. Random sequence wavelength agility on a pulse-to-pulse basis was demonstrated over a 20 nm band, and an over-all efficient tuning range approach 50 nm was demonstrated. The UTRC portion of the program, wavelength-agile injection laser technology is covered. GRA

**N91-17363#** Appalachian Regional Commission, Washington, DC.
**LASER TECHNOLOGY DEVELOPMENT FOR THE APPALACHIAN REGION Final Report**
Charles Pixton 18 May 1990 145 p
(Contract ARC-89-34-CO-9971-88-I-302-021)
(PB90-266438) Avail: NTIS HC/MF A07 CSCL 20E

In its second proposal to the Appalachian Regional Commission, the Laser Technology Center delineated ten work statements to be accomplished during the contract period. The end result of these work statements is to be economic growth for the Appalachian Region through the education and training of laser technicians and by the Laser Technology Center's applied research and development program acting as a catalyst for more efficient and high tech industrial development in the region. Discussion of progress on each task is given. Many appendices on topics such as job surveys on fiber optics in telecommunications, comments about a course on fiber optics, economic development in Tennessee through laser/electrooptic technology, and the resources and capabilities of the Laser Technology Center. GRA

**N91-17364#** Berkeley Research Association, Springfield, VA.
**THE EFFECT OF A BUMP IN THE TURBULENCE SPECTRUM ON LASER PROPAGATION**
Steven W. McDonald 1 Aug. 1990 45 p
(Contract N00014-87-C-2411)
(AD-A228723; BRA-90-358R) Avail: NTIS HC/MF A03 CSCL 17/5

This report will address the effect of a bump in the turbulence spectrum on the propagation of a laser beam. The motivation for this work is as follows: In conventional treatments on the effect of turbulence on laser propagation, it is usually assumed that the turbulence can be described by a spectral density which represents a cascade of energy from long wavelength modes down to shorter wavelength modes. The most common assumption is that of the Kolmogorov model, where in the inertial range of the spectrum (between a minimum wavenumber k(sub L0) and maximum wavenumber k(sub l0), corresponding to the maximum size L0 and minimum size l0 of the turbulent eddies) the spectral density decreases as k(sup -(3d+2)/3) (in d dimensions). In some media however, a source for injecting energy into the turbulent spectrum at a particular discrete wavelengths (or over a range of wavelengths) may be present: for example, this is the case in a turbulent plasma where an instability may be growing over a range of wavelengths. The presence of such an energy source will thus produce a bump in the turbulence spectrum, as seen below, the spectrum can then be viewed as this bump superimposed upon the background natural cascade: that is, the spectrum can be analyzed as the sum of a cascade spectrum and the bump spectrum, and the effects of each on the propagation of the beam can thus be analyzed separately. GRA

**N91-17365#** Sandia National Labs., Albuquerque, NM.
**PERFORMANCE OF THREE-CRYSTAL 1800 WATT CW Nd:YAG LASER**
J. L. Jellison, D. M. Keicher, and P. W. Fuerschbach 1990 9 p Presented at the ICALEO '90 Conference, Boston, MA, 4-9 Nov. 1990
(Contract DE-AC04-76DP-00789)
(DE91-004791; SAND-90-1596C; CONF-9011155-1) Avail: NTIS HC/MF A02

The goal of this project was to develop a laser system that would combine some of the favorable characteristics of the two most commonly used lasers for seam welding of heat sensitive assemblies. A multirod (3) symmetrical resonator CW Nd:YAG laser has been developed that is rated at 1800 watts output power. By utilizing the symmetrical resonator design, beam characteristics are not significantly compromised compared to that of single rod systems. The laser is capable of producing acceptable welds in aluminum and copper alloys and also has sufficient power to produce welds in steels and nickel base alloys at high welding speeds. DOE

**N91-17366#** Los Alamos National Lab., NM.
**THE NEXT GENERATION OF RF-FEL (FREE-ELECTRON LASER) DIAGNOSTICS: SYNCHROSCAN AND DUAL-SWEEP STREAK CAMERA TECHNIQUES**
Alex H. Lumpkin 1990 19 p Presented at the 12th International Free Electron Laser Conference (FEL-12), Paris, France, 17-21 Sep. 1990
(Contract W-7405-eng-36)
(DE91-004844; LA-UR-90-3907; CONF-9009166-15) Avail: NTIS HC/MF A03

Time-resolved experiments on RF-linac driven free-electron laser (FEL) experiments have recently been extended to displaying both the submicropulse and submacropulse effects. By using a synchroscan sweep on a streak camera key RF phase effects can be studied, and an additional dual sweep feature can provide this information during the macropulse. Successful measurements to date on the Los Alamos and Boeing FELs include electron-beam micropulse bunching during a macropulse, phase stability effects, micropulse elongation and transit time in a photoinjector, drive-laser phase stability, and FEL output evolution. Several of these measurements are the first of their kind on a FEL system . DOE

**N91-17367#** Central Research Inst. of Electric Power Industry, Tokyo (Japan). Energy and Environment Lab.
**THEORETICAL ANALYSIS OF DISCHARGES IN COPPER VAPOR LASERS: COMPARISON BETWEEN Ne AND He**
N. Goto and K. Nemoto Apr. 1990 25 p In JAPANESE; ENGLISH summary
(DE91-736781; CRIE-T-89036) Avail: NTIS HC/MF A03

This report describes a theoretical analysis method of electron transport that was developed by assuming spatial homogeneity in mixtures of copper vapor and rare gases. The results are as follows: (1) this theory gives more detailed description of electron transport than the Maxwellian; (2) the temperature of the discharge tube is an important parameter for discharges because it gives the pressure of the copper vapor and the characteristics of electron transport; and (3) included with one percent of copper vapor, the reduced field of the laser oscillation needs over 8Td in Ne and 14Td in He. DOE

**N91-17368#** Central Research Inst. of Electric Power Industry, Tokyo (Japan). Energy and Environment Lab.
**DEVELOPMENT OF LONG LIFE PULSE POWER SUPPLY FOR COPPER VAPOR LASER**
T. Fujii, N. Goto, and K. Nemoto Apr. 1990 34 p In JAPANESE; ENGLISH summary
(DE91-736783; CRIE-T-89050) Avail: NTIS HC/MF A03

A long life pulse power supply for Cu vapor laser was developed. This is composed of the pulse generation circuit and the pulse compression circuit. Current pulse of 10 mu second pulse width is generated in the pulse generating circuit by switching electric charge on the condensor charged through GTO (gate turn off) thyristors. The pulse compression circuit makes the current pulse fast to 300ms utilizing the difference of inductance at the saturation and the unsaturation on the circuit which uses a reactor having saturable property using a ferromagnetic substance for the core as the magnetic switch. The operation was carried out at the GTO generating full power. Co-base amorphous alloy of low loss was used for the core of saturable inductor and the circuit efficiency

of 77 percent could be obtained by suppressing the heat generation in core even at 4,000Hz operation. The full output power of 8.2kW was possible which corresponds to 100W class laser oscillation. Repeated Cu vapor laser oscillation of 30W succeeded at the condition of 4,000Hz and power supply output of 5.9kW. DOE

**N91-17369#** Central Research Inst. of Electric Power Industry, Tokyo (Japan). Energy and Environment Lab.
**WAVELENGTH CONTROL OF VISIBLE LIGHT LASER DIODES**
N. Goto, T. Fujii, K. Nemoto, H. Suzuki, K. Nakagawa, and M. Otsu (Tokyo Inst. of Tech., Japan ) Apr. 1990 38 p In JAPANESE; ENGLISH summary
(DE91-736784; CRIE-T-89052) Avail: NTIS HC/MF A03

Wavelength control of visible light laser diodes was studied. By combining an interferometer and a diffraction grating, it became possible to control the wavelength of continuous oscillation in the range of 664 to 673nm, the frequency fine control range being 2GHz. And the spectral linewidth was narrowed to about 44kHz (10 exp minus 7 nm). With the use of a collimator lens, the beam expansion was narrowed to 2mrad. It was confirmed that the pulse output of continuous oscillation visible light laser diodes can be amplified by the YAG laser excitation dye laser. In the case of pulse oscillation, oscillation of 1GHz spectral width was obtained at the wavelength of 0.8 micro m by using an injection synchronization method. In the injection synchronization method, other laser beam is injected in an oscillator and a superior laser beam of synchronized components alone is obtained. As the wavelength control method is now stabilized and satisfies the conditions of narrow band, it has the prospect to be applied to the laser uranium enrichment technology. DOE

**N91-17370#** National Defence Research Establishment, Linkoeping (Sweden). Dept. of Information Technology.
**A MONTE CARLO SIMULATION MODEL OF AIRBORNE HYDROGRAPHIC LASER SYSTEMS**
Thomas Kaijser Jul. 1990 61 p
(PB91-110999; FOA-C-30578-8.1; ISSN-0347-3708) Avail: NTIS HC/MF A04 CSCL 20E

A Monte Carlo simulation model is described of lidar measurements obtained by airborne hydrographic laser systems. A new model is introduced for light propagation in water, and it is shown that simulation results based on this model agree with simulation results based on previously used light propagation models, but that they require considerably less computer time. The Monte Carlo simulation model includes the possibility to have a water basin consisting of several horizontal water layers, as well as an object within the water basin. Several computer experiments are given for which the effects on the lidar response due to various parameters are described. A surprising phenomena are also explained which are called the lifting phenomena.
Author

**N91-17371** Colorado State Univ., Fort Collins.
**MODELING OF CW ELECTRON BEAM SUSTAINED ION LASERS Ph.D. Thesis**
Gregory James Fetzer 1990 118 p
Avail: Univ. Microfilms Order No. DA9029415

Two electron beam sustained discharge lasers are studied. The first electron beam excitation scheme exploits direct electron impact excitation of the laser levels responsible for the blue-green transitions in Ar II. The second utilized selective excitation, of a red transition in the mercury ion via resonant charge transfer between neutral mercury and helium ions in the negative glow of a hollow cathode discharge. First, a self-consistent model of an argon ion laser excited by low energy dc electron beams is discussed. The motivation for this work was to determine the feasibility of developing an argon ion laser with improved efficiency in comparison to positive column devices. Optical gains, power, and laser efficiencies were computed for the 4765, 4880, 4965, and 4658 A Ar II transitions. The model predicts small signal gain coefficients which are in agreement with experimental measurements at low current densities. Secondly, a dc hollow cathode discharge helium mercury laser is studied. The model discussed is the first self-consistent description of a hollow cathode discharge. Parameters free for adjustment in the model are the voltage, the gas pressures, and cathode materials, as is the case for actual laboratory devices. The mode self-consistently calculates the discharge current by computing the spatial evolution of the energies of charged particles in the cathode sheath and the corresponding electron energy distribution and ion densities in the negative glow. The laser gain, output power, and efficiency are calculated as a function of discharge current and voltage, buffer gas pressure, and metal vapor density. Dissert. Abstr.

**N91-17372#** Wright Research Development Center, Wright-Patterson AFB, OH. Electromagnetic Materials and Survivability Div.
**MULTI-SYSTEM LASER SAFETY SHUTTER CONTROLLER Final Report, Sep. 1989 - Sep. 1990**
E. Thomas Kensky Oct. 1990 84 p
(AF Proj. 2306)
(AD-A229280; WRDC-TR-90-4102) Avail: NTIS HC/MF A05 CSCL 09/3

The use of lasers in research laboratories has become commonplace. With this increased use of lasers comes the inherent danger from laser radiation to the user. While burns are thought of as the primary danger from lasers, a more immediate hazard is the loss of eye sight. This danger increases in laboratory environments where it is impractical to completely enclose the beam path. To provide an increased level of safety for these instances, a laser safety shutter controller has been designed and implemented. This system provides and effective interface between the laboratory entrances and accompanying safety shutters to provide laser beam blockage during a laboratory breach. In addition, this system provides a host of convenience features that allow the laser user to easily control laser emission. These features include shutter and interlock control of up to eight independent lasers, push button shutter control and infrared remote control. GRA

**N91-17373#** Sandia National Labs., Albuquerque, NM.
**CALORIMETRIC MEASUREMENTS OF ENERGY TRANSFER EFFICIENCY AND MELTING EFFICIENCY IN CO2 LASER BEAM WELDING**
P. W. Fuerschbach 1990 18 p Presented at the JOWOG 22D Joining Subgroup Meeting, Los Alamos, NM, 23-25 Oct. 1990
(Contract DE-AC04-76DP-00789)
(DE91-005861; SAND-90-3114C; CONF-9010282-2) Avail: NTIS HC/MF A03

The previous calorimetric studies of weld melting efficiency and arc efficiency in the GTAW and PAW processes have naturally led us to speculate as to the magnitude of the efficiencies in the LBW process which to data have also not been adequately investigated. Most welding engineers that have had experience with the LBW process are acutely aware that the metals' absorptivity, the surface finish, and the laser wavelength, all play an important role in affecting the energy transfer efficiency, but the extent of their influence and our understanding of the influence of other process variables is not well understood. In addition, it is widely thought that only the LBW or EBW processes can be selected for applications where thermal damage and distortion from the welding process must be kept to a minimum. For these reasons, we have looked forward to performing these calorimetric experiments since they potentially can answer such important questions as: whether or not the melting efficiency of the LBW process is superior to that obtainable with conventional GTAW and PAW welding processes. This study was prompted by poor production yields on switching device due to cracking of the ceramic header after final closure welding with the CO2 LBW process. This calorimetric study was begun in hopes of determining if allowed variations in production process control variables were responsible for increases in heat input and the resulting thermal stresses. By measuring the net heat input to the workpiece with the calorimeter and by measuring the laser output energy and the weld fusion

zone size it was possible to determine the magnitudes of both the energy transfer efficiency and the melting efficiency as well as observe their dependence on the process variables. DOE

**N91-17374#** Los Alamos National Lab., NM. Chemical and Laser Sciences Div.
**EFFECTS OF PROCESSING PARAMETERS ON THE LASER DEPOSITION OF HIGH TEMPERATURE SUPERCONDUCTING THIN FILMS**
N. S. Nogar, R. Castain, R. C. Dye, S. Foltyn, R. E. Muenchausen, and X. D. Wu 1990 7 p Presented at the Fall Meeting of the Materials Research Society, Boston, MA, 26-30 Nov. 1990
(Contract W-7405-eng-36)
(DE91-005937; LA-UR-90-4418; CONF-901105-53) Avail: NTIS HC/MF A02

Y2O3 pressed powders were ablated by pulses from a XeCl excimer laser, operating at 308 nm, 150 mJ/pulse, approximately equals 15 nsec/pulse and 20 Hz. Emission spectra from Y* and YO* were recorded as a function of ambient oxygen pressure in the range 10(exp -5) to 4 x 10(exp -1) Torr, at a laser fluence of approximately 4J/sq cm. A kinetic model is developed to describe the results, and the application to production of laser-deposited high-temperature superconductor thin films is discussed. DOE

**N91-17375#** Lawrence Livermore National Lab., CA.
**WAVE OPTICS MODELLING OF AMPLIFIED SPONTANEOUS EMISSION**
Burke Ritchie and John Garrison 6 Nov. 1990 6 p Presented at the 1990 Nuclear Explosives Code Developers' Conference, Monterey, CA, 6-9 Nov. 1990 Submitted for publication
(Contract W-7405-eng-48)
(DE91-006238; UCRL-JC-105621; CONF-9011149-8) Avail: NTIS HC/MF A02

A laser works by amplified spontaneous emission (ASE) of inverted atomic ions confined in an amplifier of rod-like geometry, such that ASE radiation is directed out of both ends of the rod. The forward and backward ASE waves are coupled through the population-rate equations and cause the saturation of the lasing transition (gain saturation). Diffraction of the waves in the transverse direction is responsible for the radiation pattern (angular distribution) observed on a distant screen and for the degree of spatial coherence of the radiation. Refraction of the light also occurs due to spatial gradients in the electron density. In order to describe this situation a code has been developed which numerically solves paraxial Maxwell's equations in the time and two spatial dimensions. The code uses the Peaceman-Rachford Alternating-Direction-Implicit algorithm and is benchmarked against laboratory dye-laser experiments. DOE

**N91-17376#** Lawrence Livermore National Lab., CA.
**DAMAGE RESISTANT OPTICS FOR A MEGA-JOULE SOLID-STATE LASER**
J. H. Campbell, F. Rainer, M. R. Kozlowski, C. R. Wolfe, I. Thomas, and F. Milanovich 17 Dec. 1990 15 p Presented at the 22nd Boulder Damage Symposium, Boulder, CO, 24-26 Oct. 1990 Submitted for publication
(Contract W-7405-eng-48)
(DE91-006246; UCRL-JC-104900; CONF-9010287-5) Avail: NTIS HC/MF A03

Research on Inertial Confinement Fusion (ICF) has progressed rapidly in the past several years. As a consequence, LLNL is developing plans to upgrade the current 120 kJ solid state (Nd3+ phosphate glass) Nova laser to a 1.5 to 2 megajoule system with the goal of achieving fusion ignition. The design of the planned Nova Upgrade is briefly discussed. Because of recent improvements in the damage resistance of optical materials it is now technically and economically feasible to build a megajoule-class solid state laser. Specifically, the damage threshold of Nd(+3)-doped phosphate laser glass, multilayer dielectric coatings, and non-linear optical crystals (e.g., KDP) have been dramatically improved. These materials now meet the fluence requirements for a 1.5 to 2 MJ Nd(+3)-glass laser operating at 1054 and 351 nm and at a pulse length of 3 ns. The recent improvements in damage thresholds are reviewed; threshold data at both 1064 and 355 nm and the measured pulse length scaling are presented. DOE

**N91-17377#** Sandia National Labs., Albuquerque, NM.
**SURFACE-EMITTING LASER LOGIC**
G. R. Olbright, R. P. Bryan, T. M. Brennan, K. Lear, G. E. Poirier, W. S. Fu, J. L. Jewell, and Y. H. Lee (Bell Telephone Labs., Inc., Holmdel, NJ.) 31 Oct. 1990 5 p Presented at the Photonic Switching Topical Meeting, Salt Lake City, UT, 6-8 Mar. 1991 Revised Submitted for publication
(Contract DE-AC04-76DP-00789)
(DE91-005055; SAND-90-2800C; CONF-910377-1) Avail: NTIS HC/MF A01

We describe a new class of optical logic devices which consist of integrated phototransistors and surface-emitting lasers. The devices function as optical neurons having high gain and, as arrays, are ideal for neural networks, parallel optical signal processing and optical computing applications. DOE

**N91-17378#** Lawrence Livermore National Lab., CA.
**HIGH POWER CW PERFORMANCE FROM A Ti:SAPPHIRE LASER AND A SINGLE-PASS AMPLIFIER**
G. V. Erbert, I. L. Bass, R. P. Hackel, S. Jenkins, K. V. Kanz, and J. A. Paisner 7 Nov. 1990 6 p Presented at the International Conference on Lasers 1990, San Diego, CA, 10-14 Dec. 1990 Submitted for publication
(Contract W-7405-eng-48)
(DE91-005269; UCRL-JC-105386; CONF-901263-1) Avail: NTIS HC/MF A02

Using two argon-ion lasers to pump a CW Ti:Sapphire laser, we have demonstrated consistent high power (19 watts) operation with a low order spatial mode. Thermal lensing effects were controlled by enclosing the laser in a vacuum and cooling the rod with liquid nitrogen. Using this laser we also demonstrated a CW Ti:Sapphire amplifier with an efficiency of 20 percent. DOE

**N91-17379#** Los Alamos National Lab., NM.
**THERMAL ANALYSIS OF MULTIFACET-MIRROR RING RESONATOR FOR XUV FREE-ELECTRON LASERS**
Brian D. McVey, John C. Goldstein, Robert D. McFarland, and Brian E. Newnam 10 Dec. 1990 13 p Presented at the 22nd Boulder Damage Symposium, Boulder, CO, 25-26 Oct. 1990
(Contract W-7405-eng-36)
(DE91-005855; LA-UR-90-4318; CONF-9010287-1) Avail: NTIS HC/MF A03

XUV (10 nm less than or equal to lambda less than or equal to 100 nm) free-electron lasers (FELs) are potentially important light sources for advanced lithography and materials applications. The average power of an XUV FEL oscillator may be limited by thermal loading of the resonator mirrors. We analyze the requirements for the thermal performance of the mirrors of a metal, multifacet-mirror ring resonator for use at 12 nm. We use analytical methods and numerical approaches which include simulations with the 3-D FEL code FELEX. Thermal distortion of mirror surfaces leads to optical wavefront aberrations which reduce the focusability of the light beam in the gain medium (wiggler/electron beam) and limit the laser performance. DOE

**N91-17380#** Lawrence Livermore National Lab., CA.
**RECOMBINATION X RAY LASER EXPERIMENTS USING EXPLODING RIBBON Al TARGETS**
C. J. Keane, D. C. Eder, B. J. MacGowan, D. L. Matthews, and D. A. Whelan 1 Nov. 1990 6 p Presented at the 32nd Annual Meeting of the American Physical Society, Cincinnati, OH, 12-16 Nov. 1990
(Contract W-7405-eng-48)
(DE91-006710; UCRL-JC-104407; CONF-9011127-16) Avail: NTIS HC/MF A02

Data obtained from recent recombination x ray laser experiments is presented which were carried out at the Nova and Phebus lasers using exploding ribbon Al targets irradiated with 100 ps pulses of 0.53 micron light. Spatially and temporally resolved

x ray and soft x ray spectra are shown. These spectra revealed the plasma to be insufficiently ionized so as to produce inversions in H-like Al. Conditions were found to be appropriate for inversion in He- and Li-like Al, however, and evidence for amplification of the AlXI 105.7A (5f-3d) and AlXII 88.9 (5f-3d) and 130.1A (4f-3d) lines was seen. These results are discussed in detail and related to other work regarding the discrepancies between expected and measured electron temperatures in plasmas of this type. DOE

**N91-17381#** Lawrence Livermore National Lab., CA. Laser Program.
**DESIGN AND PERFORMANCE OF A MULTITERAWATT, SUBPICOSECOND NEODYMIUM GLASS LASER**
F. G. Patterson and M. D. Perry Sep. 1990 14 p
(Contract W-7405-eng-48)
(DE91-006749; UCRL-ID-104993) Avail: NTIS HC/MF A03

Broadband solid state materials such as Nd:Glass, Ti:Sapphire and Alexandrite, exhibit saturation fluences on the order of Joules/sq cm. Unfortunately, the large stored energy density of these solid state materials cannot be accessed directly with short pulses due to beam filamentation caused by the intensity dependent refractive index. This limits the power density in a solid state amplifier to only a few GW/sq cm. The application of chirped-pulsed amplification (CPA) to solid state lasers circumvents this problem. With the CPA technique, a chirped, comparatively long pulse is produced and compressed to a short pulse only after amplification. The intensity in the amplifiers is kept below the level for significant nonlinear phase distortion. The design and performance is presented of a small scale Nd:Glass laser system employing chirped-pulse amplification to produce subpicosecond pulses exhibiting peak power exceeding 10 TW. DOE

**N91-17382*#** Stanford Univ., CA. Physics Lab.
**SOLID-STATE LASERS FOR COHERENT COMMUNICATION AND REMOTE SENSING Semiannual Progress Report, 1 Apr. - 30 Sep. 1990**
Robert L. Byer Feb. 1991 44 p
(Grant NAGw-1760)
(NASA-CR-187686; NAS 1.26:187686) Avail: NTIS HC/MF A03 CSCL 20E

Work in the stabilization of monolithic Nd:YAG lasers and the application of these lasers to nonlinear optical frequency conversion is discussed. The intrinsic stability of semiconductor diode laser pumped solid state lasers has facilitated a number of demonstration in external resonant cavity harmonic generation and stable optical parametric oscillation. Relative laser frequency stabilization of 0.3 Hz was achieved, and absolute stability of a few hundred hertz is anticipated. The challenge is now to reproduce this frequency stability in the output of tunable nonlinear optical devices. Theoretical and experimental work toward this goal are continuing. Author

# 37 MECHANICAL ENGINEERING

Includes auxiliary systems (nonpower); machine elements and processes; and mechanical equipment.

**N91-17383#** Oak Ridge National Lab., TN.
**PERFORMANCE OF MULTIPLE TASKS BY AN AUTONOMOUS ROBOT USING VISUAL AND ULTRASOUND SENSING**
M. Beckerman, D. L. Barnett, M. Dickens, and C. R. Weisbin (Jet Propulsion Lab., California Inst. of Tech., Pasadena.) 1990 8 p Presented at the ISRAM '90: International Symposium on Robotics and Automation, Vancouver, British Columbia, 18-20 Jul. 1990
(Contract DE-AC05-84OR-21400)
(DE90-010719; CONF-900780-2) Avail: NTIS HC/MF A02

While there have been many successful mobile robot experiments, only a few papers have addressed issues pertaining to the range of applicability, or robustness, of robotic systems. The purpose of this paper is to report results of a series of benchmark experiments done to determine and quantify the robustness of an integrated hardware and software system of a mobile robot. DOE

**N91-17384#** Oak Ridge National Lab., TN. Fuel Recycle Div.
**A FULLY OMNIDIRECTIONAL WHEELED ASSEMBLY FOR ROBOTIC VEHICLES**
Stephen M. Killough and Francois G. Pin 1990 5 p Presented at the American Nuclear Society Annual Meeting, Nashville, TN, 10-14 Jun. 1990 Submitted for publication
(Contract DE-AC05-84OR-21400)
(DE90-011640; CONF-900608-20) Avail: NTIS HC/MF A01

Mobile robotic platforms are currently being investigated for transporting robots to various work sites and assisting robot movements at the work site. An ideal platform would be one with full 3-degree-of-freedom (DOF) movement (x,y translation and rotation) to enable tighter navigation and docking, obstacle avoidance, and improved manipulator reach. Three DOFs would also simplify control of the platform and make it more general, thus providing more opportunities for autonomous control. Such a 3-DOF platform has been developed at the Oak Ridge National Laboratory and is being used for artificial intelligence research. Mathematical details on how these platforms are configured and controlled are also discussed. DOE

**N91-17385** California Univ., Berkeley.
**THEORY AND IMPLEMENTATION OF ADAPTIVE AND REPETITIVE CONTROL FOR ROBOT MANIPULATORS Ph.D. Thesis**
Ming-Chang Tsai 1989 158 p
Avail: Univ. Microfilms Order No. DA9029053

Theory and implementation of model reference adaptive control (MRAC) and repetitive control for robot manipulators are presented. The MRAC approach deals with the situation when robot parameters, e.g., payload, are time varying or not known in advance. The repetitive control scheme has the ability to reject periodic disturbance and assures asymptotically perfect tracking for periodic desired trajectories. The use of a pure integrator reference model and a unity gain reference model are first studied in the continuous time domain. The MRAC scheme with the unity gain reference model is a pure integrator, the velocity error becomes the adaptation error signal. Global stability and perfect tracking under these two adaptive controllers are proven. Sufficient conditions that guarantee stability and boundness of tracking errors and parameter estimation errors are presented for the hybrid schemes. Periodic signals with a known period can be generated by a time delay block with positive feedback. Based on the internal model principle, regulation under periodic disturbance can be achieved by including the periodic signal generator in the controller, The design and analysis of a discrete time repetitive controller for robot manipulators are studied. Combinations of the MRAC and the repetitive control schemes for robot manipulators are also studied. Stability conditions are presented both in continuous and discrete time domains. Computer simulation and experimental evaluation of the MRAC and the repetitive controller are performed. Dissert. Abstr.

**N91-17386*#** Texas A&M Univ., College Station. Dept. of Mechanical Engineering.
**LOCAL SENSORY CONTROL OF A DEXTEROUS END EFFECTOR Final Report, Jan. 1988 - Dec. 1990**
Victor H. Pinto, Louis J. Everett, and Morris Driels (Naval Postgraduate School, Monterey, CA.) Dec. 1990 87 p
(Grant NAG9-326)
(NASA-CR-187710; NAS 1.26:187710) Avail: NTIS HC/MF A05 CSCL 13I

A numerical scheme was developed to solve the inverse kinematics for a user-defined manipulator. The scheme was based on a nonlinear least-squares technique which determines the joint variables by minimizing the difference between the target end effector pose and the actual end effector pose. The scheme was adapted to a dexterous hand in which the joints are either prismatic or revolute and the fingers are considered open kinematic chains. Feasible solutions were obtained using a three-fingered dexterous

hand. An algorithm to estimate the position and orientation of a pre-grasped object was also developed. The algorithm was based on triangulation using an ideal sensor and a spherical object model. By choosing the object to be a sphere, only the position of the object frame was important. Based on these simplifications, a minimum of three sensors are needed to find the position of a sphere. A two dimensional example to determine the position of a circle coordinate frame using a two-fingered dexterous hand was presented. Author

**N91-17387*** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
**COMPLIANT JOINT Patent**
Wayne D. Eklund, inventor (to NASA) and James J. Kerley, inventor (to NASA) 12 Jun. 1990 9 p Filed 21 Mar. 1989
(NASA-CASE-GSC-13153-1; US-PATENT-4,932,806; US-PATENT-APPL-SN-326863; US-PATENT-CLASS-403-57; US-PATENT-CLASS-403-113; US-PATENT-CLASS-403-291; US-PATENT-CLASS-464-56; US-PATENT-CLASS-464-132; INT-PATENT-CLASS-F16D-3/02) Avail: US Patent and Trademark Office CSCL 13I

A compliant joint is provided for prosthetic and robotic devices which permits rotation in three different planes. The joint provides for the controlled use of cable under motion. Perpendicular outer mounting frames are joined by swaged cables that interlock at a center block. Ball bearings allow for the free rotation of the second mounting frame relative to the first mounting frame within a predetermined angular rotation that is controlled by two stop devices. The cables allow for compliance at the stops and the cables allow for compliance in six degrees of freedom enabling the duplication or simulation of the rotational movement and flexibility of a natural hip or knee joint, as well as the simulation of a joint designed for a specific robotic component for predetermined design parameters.
Official Gazette of the U.S. Patent and Trademark Office

**N91-17388*** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
**ROBOT CABLE-COMPLIANT DEVICES Patent**
James J. Kerley, Jr., inventor (to NASA) 7 Aug. 1990 17 p Filed 13 May 1988
(NASA-CASE-GSC-13127-1; US-PATENT-4,946,421; US-PATENT-APPL-SN-193612; US-PATENT-CLASS-464-56; US-PATENT-CLASS-901-28; INT-PATENT-CLASS-F16D-3/50)
Avail: US Patent and Trademark Office CSCL 13I

A cable compliant robotic joint includes two U configuration cross section brackets with their U cross sections lying in different planes, one of their brackets being connected to a robot arm and the other to a tool. Additional angle brackets are displaced from the other brackets at corners of the robotic joint. All the brackets are connected by cable segments which lie in one or more planes which are perpendicular to the direction of tool travel as it approaches a work object. The compliance of the joint is determined by the cable segment characteristics, such as their length, material, angle, stranding, pretwisting, and prestressing.
Official Gazette of the U.S. Patent and Trademark Office

**N91-17389#** Detroit Diesel Allison, MI.
**FEASIBILITY STUDY OF A 6V-92TA HOMOGENEOUS AUTO-IGNITED TWO-STROKE (HAT) COMPRESSED NATURAL GAS ENGINE Topical Report, Aug. 1989 - May 1990**
R. M. Kakwani and R. E. Winsor Aug. 1990 45 p
(Contract GRI-5089-292-1813)
(PB91-106278; GRI-90/0249) Avail: NTIS HC/MF A03 CSCL 13I

The main objective was to modify a two-stroke 6V-92TA diesel engine to operate on natural gas using a simple system with gas addition to the compressor inlet and a spark plug for cold start and non-autoignition engine operation. The engine was to be operated at most speed-load conditions by autoignition of the premixed gas-air mixture. This concept is referred as the Homogeneous Auto-Ignited Two-Stroke (HAT). Autoignition of carbureted natural gas was achieved at various loads and speeds in a 6V-92TA engine modified for operating on natural gas with the HAT concept. Author

**N91-17390#** Federal Railroad Administration, Washington, DC.
**MOVING AMERICA: NEW DIRECTIONS, NEW OPPORTUNITIES. ASSESSMENT OF THE POTENTIAL FOR MAGNETIC LEVITATION TRANSPORTATION SYSTEMS IN THE UNITED STATES. A REPORT TO CONGRESS**
Jun. 1990 34 p
(PB91-104588) Avail: NTIS HC/MF A03 CSCL 13F

This report is divided into the following sections: (1) introduction and background; (2) current state of maglev technology; (3) preliminary analysis of the technical feasibility of maglev systems; (4) preliminary analysis of the economic feasibility of maglev systems; and (5) measures to promote U.S. leadership in maglev development. The report supplement presents a more detailed exposition of these issues. GRA

**N91-17391** Virginia Univ., Charlottesville.
**DYNAMIC ANALYSIS OF LIQUID-LUBRICATED HYDROSTATIC JOURNAL BEARINGS Ph.D. Thesis**
John Anthony Kocur, Jr. 1990 269 p
Avail: Univ. Microfilms Order No. DA9100822

A hybrid bearing reduces the dependency of its behavior on the lubricant viscosity, bearing clearance, bearing surface area by combining the hydrostatic and hydrodynamic effects. The combination permits the hybrid bearing to be incorporated into rotor designs, where the working fluids of the rotor may be used in place of externally supplied lubricants. An effective and practical method to predict the static and dynamic behavior of hybrid bearings is developed. The model includes the three major fluid effects in the bearing; the orifice restriction, inertia losses at the pocket edges, and hydrodynamic effects on the bearing land regions. Lubrication is modeled and calculated using a finite element solution of Reynolds equation with turbulence corrections. Dissert. Abstr.

**N91-17392** Michigan Univ., Ann Arbor.
**THE MECHANISM OF SCUFFING IN LUBRICATED SLIDING Ph.D. Thesis**
Youngze Lee 1990 124 p
Avail: Univ. Microfilms Order No. DA9034463

Surface changes that occur on lubricated sliding steel surfaces, the films formed on these surfaces, and the roughness of the surface changes were investigated. Surface failure was found to be non-predictable by comparing lubricant film thickness with the height of asperities. The reason is that protective chemical species form on the asperities to prevent high surface shear stress. These films form in all practical systems, but are particularly effective when a proper running-in procedure is followed. Dissert. Abstr.

**N91-17393** Texas Univ., Austin.
**ROBUST CONTROL SYNTHESIS FOR UNCERTAIN DYNAMICAL SYSTEMS Ph.D. Thesis**
Kuk Whan Byun 1990 273 p
Avail: Univ. Microfilms Order No. DA9031530

Stability robustness and performance are opposing objectives in control systems design. Generic models of flexible space structures and the Space Station are employed as examples to investigate such important issues arising in robust control designs. A new generalized structural filtering concept is developed for active vibration control synthesis. This concept is a generalization of classical gain/phase stabilization. Non-minimum phase stabilization is shown to be a particularly effective means of active vibration control in the presence of plant uncertainty. The concept is combined with a quantitative feedback design method to develop a robust frequency-domain control synthesis technique, which yields a nonconservative design for a single-input single-output control system. A robust H(sub infinity) control synthesis technique is also developed in the state-space by utilizing the concept of input-output decomposition, which effectively handles parameter variations in robust control synthesis. A simplified method of H(sub infinity)

controller parameterization is developed by modifying the available approaches. These synthesis techniques are then applied to flexible structure control, resulting in non-minimum phase compensation. The robust H(sub infinity) control design technique is applied to momentum/attitude control of the Space Station, which yields a remarkable result in stability robustness with respect to the inertia variations. Dissert. Abstr.

**N91-17394** Nevada Univ., Reno.
**NONLINEAR DYNAMICS AND CONTROL OF A SPATIAL HIGH SPEED COMPOSITE-MATERIAL FLEXIBLE ROBOT ARM Ph.D. Thesis**
Assadollah Ghazavi 1990 205 p
Avail: Univ. Microfilms Order No. DA9032552

The focus of this work is to amend the end effector positional accuracy of high speed, light weight, flexible robotic manipulators. Demonstrated here is the enhancement achieved by active and passive compensations of the end effector static and dynamic deflections of the tip of a flexible robot arm. The passive compensation is accomplished by constructing the flexible link from advanced composite materials. The active compensation is done by using a nonlinear control technique whose control law includes the dynamics and flexibility of the manipulator. Hamilton's principle is used to derive the equations of motion of a three degree of freedom revolute manipulator. The last link of the robotic manipulator is considered to be flexible and is constructed from either aluminum or graphite epoxy. Digital simulations are performed to investigate the dynamic behavior and control response. Comparisons are made between the dynamic behavior of robot arms fabricated from conventional metallic materials and advanced composite materials to demonstrate the excess accuracy gained by the use of composite materials. The results of the implementation of different controllers and their effect on links constructed from either aluminum or graphite epoxy are analyzed. Dissert. Abstr.

**N91-17395** Northwestern Univ., Evanston, IL.
**HYDRODYNAMIC LUBRICATION UNDER SEVERE CONDITIONS Ph.D. Thesis**
Xiubao Huang 1990 232 p
Avail: Univ. Microfilms Order No. DA9031926

Three different rheological models for viscoplastic lubricants were compared and Reynolds equations developed. The Reynolds equations were applied to analyze the wide slider bearing, the short slider bearing, and the metal forming inlet zone. The element analysis method, which reveals the local effect of asperities, was developed and applied to generate an average flow model for rough surface lubrication with isoviscous lubricants. Simple analytical expressions for flow factors and shear stress factors were derived, and were applied in the analyses of a wide slider bearing and a metal forming inlet zone. The method was also used to calculate the pressure distribution and load capacity for these cases when the number of asperities are finite. The Reynolds equation and a semiempirical plasticity equation were coupled to solve for the film shape and pressure profile for different loading conditions in a metal forming work zone with rough tooling. The combined effect of roughness and temperature difference between two surfaces were studied. The modified element analysis method was used to derive a modified average Reynolds equation, modified flow factors, and shear stress factors for thermoviscous lubricants. Dissert. Abstr.

**N91-17396** Texas Univ., Austin.
**CONSTRUCTION MANIPULATOR TELEOPERATION WITH ERGOSTICKS Ph.D. Thesis**
Peter Jonathan Hughes 1990 322 p
Avail: Univ. Microfilms Order No. DA9031596

Cost effective control of a large manipulator for industrial construction was investigated. This research was based on physical testing of the Dupont/Grove Pipe Manipulator, which featured a 750 kg capacity, 20 m radius, and an eight axis hydraulic arm with load gripping jaws on a mobile chassis. This machine was built in 1980 for the erection of pipe spools during petrochemical plant construction. It fell into disuse due to poor performance as compared to a conventional crane with rigging crew. Alternatives to the cumbersome lever-box operator interface were explored. Interfaces for other large scale machines were found to be expensive in terms of development cost and installed controls. These were justifiable in the U.S. only where unmanned operation was demanded. A plan for an arm control system with incremental upgrade steps was created. The first step of this plan was physically implemented as the Ergosticks teleoperator. This replica rate controller was used to validate the hypothesis that the pipe manipulator will compete with a conventional crane in pipe spool erection, by use of a simple teleoperator interface for arm control. This hypothesis was disproved when testing the Ergosticks with open loop driving of manipulator hydraulic actuators. Erratic manipulator response overwhelmed potential improvement offered by the intuitive Ergosticks interface. Wrist orientation at pick and place positions remained particularly troublesome. Test data proved the hypothesis with the Ergosticks and automatic manipulator wrist control. This allowed computer operation of the tedious orientation, and retained the operator for high level task planning and collision free translations about the job site. Fourteen other areas for pipe manipulator improvement are described for near term usefulness of the teleoperated machine, or for speculative study of a CAD database driven machine. Dissert. Abstr.

**N91-17397** Texas Univ., Austin.
**A UNIVERSAL BILATERAL/FORCE-REFLECTING MANUAL CONTROLLER DESIGN, CONTROL, AND IMPLEMENTATION Ph.D. Thesis**
Whee-kuk Kim 1990 237 p
Avail: Univ. Microfilms Order No. DA9031619

A force reflecting, three degree of freedom (DOF) spherical manual controller for a teleoperator system was designed, analyzed and implemented as a test bed demonstration. To achieve an improved level of design to meet criteria such as compactness, portability, and a somewhat enhanced force-reflecting capability, the demonstration manual controller employs high gear ratio reducers. To reduce the effects of inertia and friction on the system, various force control strategies are applied and their performance investigated. The spherical manual controller uses a parallel geometry to minimize inertial and gravitational effects in its primary task of transparent information transfer. As an alternative to the spherical three DOF manual controller, a new conceptual hybrid (or parallel) spherical three DOF module is introduced with a full kinematic analysis. Also, the resulting kinematic properties are compared with those of other typical spherical three DOF systems. The conceptual design of a parallel six DOF manual controller and its kinematic analysis is presented. This six DOF manual controller is similar to the Stewart Platform with the actuators located on the base to minimize the dynamic effects. Finally, a combination of the new three DOF and six DOF concepts is presented as a feasible test bed for enhanced performance in a nine DOF system. Dissert. Abstr.

**N91-17398** Florida Univ., Gainesville.
**PLANNING COLLISION-FREE PATHS WITH APPLICATIONS TO ROBOT MANIPULATORS Ph.D. Thesis**
Ihn Namgung 1989 173 p
Avail: Univ. Microfilms Order No. DA9030066

A new approach for planning a feasible collision free path based on a Bezier curve of order two, a parabola, was developed for 1-D and 3-D environments. It is assumed that obstacles are stationary and the shape and location of obstacles are known. The algorithm involves geometric analysis and produces a path connecting a user specified start and target point which does not interfere with any obstacles. The algorithm consists of three parts: a geometric mapping of obstacles; selection of intermediate points; and smoothing of the final path. The main property of the geometric mapping is that a point in the parameter space which is not mapped by obstacle images, corresponds to a collision free parabola in Euclidean space. Three supporting algorithms (expansion of obstacles, collision recognition, and change of configuration without changing the end effector position) are developed for collision

avoidance of two robots. Animated simulation of collision free path generation and collision avoidance of the robots was implemented on a graphics workstation. Dissert. Abstr.

**N91-17399** Illinois Inst. of Tech., Chicago.
**EFFECT OF DYNAMIC PLASTIC DEFORMATION ON THE NORMAL PENETRATION OF METALLIC PLATES Ph.D. Thesis**
Mohamed Kamal Shoukry 1990 109 p
Avail: Univ. Microfilms Order No. DA9030479

An attempt to develop an engineering model to predict the response of thin and intermediate thick metallic plates impacted normally by rigid, blunt cylindrical projectiles at subordnance impact speeds (100 to 300 m/s) is presented. The analysis considers the dynamic plastic plate deformation in conjunction with the plugging process as a failure mode for penetration. Liss' penetration model (1982, 1983) is used to describe the behavior of the target material in the impact zone (the area under the projectile), and a dynamic plastic bending model, including the effect of transverse shear, is used to describe the global response of the target plate. The effect of transverse shear is taken into account in the yield criterion of the plate material as well as in the dynamic equilibrium equations. A rate-independent, rigid-perfectly plastic material is assumed in conjunction with a linearized form of the von Mises yield criterion in three dimensions. The penetration model is coded in a computer program where the interaction between the local plugging model and the global target deformation is analyzed. A number of ballistic tests were conducted to examine the response of the target plates to impact loadings including perforation. A compressed-gas gun was designed, built, and used to launch steel projectiles against 6.4 mm thick aluminum plates at impact speeds of 100 to 300 m/s. Analytical and experimental results showed good agreement for the final deformation of the target plate and for the projectile residual speed after perforation. Comparison with previous models showed an improvement in the prediction of the total deformation of the target plates. Dissert. Abstr.

**N91-17400** Northwestern Univ., Evanston, IL.
**FRICTION AND WEAR MODELING IN GEARS Ph.D. Thesis**
Shifeng Wu 1990 148 p
Avail: Univ. Microfilms Order No. DA9032017

A simplified analytical friction model was advanced in the regime of partial-elastohydrodynamic contacts where the friction is affected by both asperity interactions and hydrodynamic effects. This analytical friction model is then applied to the analysis of power loss in spur gears due to sliding and rolling friction. Results based on this friction model suggest that the variations in both surface roughness and coefficient of asperity friction can alter appreciably the traction coefficient. Reduction in traction coefficient can improve the efficiency of gears. A small-scale two-disc machine apparatus which simulates the spur gear tooth contacts is designed and constructed. Traction measurements on this two-disk machine are carried out for one type of gear lubricant. The experimental results are correlated with an analytical approach to determine empirically the lubricant rheological parameters which are the necessary constants in the friction model for partial-EHL contacts. A sliding wear model was developed for partial-elastohydrodynamic contacts, in which both the thermal desorption wear mechanisms at elevated asperity contact temperature and the oxidative wear mechanism at elevated asperity contact temperature are considered. To include micro-EHL effects, digitized actual surface roughness profiles are used to simulate two contacting rough discs, and in obtaining the asperity contact area and asperity contact temperature distributions within a Hertzian contact region. Wear measurements in this two-disc machine configuration were made over a comprehensive range of slide-to-roll ratios. Dissert. Abstr.

**N91-17401*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
**ROLLING FRICTION ROBOT FINGERS Patent Application**
John M. Vranish, inventor (to NASA) 17 Dec. 1990 48 p
(NASA-CASE-GSC-13261-1; NAS 1.71:GSC-13261-1; US-PATENT-APPL-SN-628529) Avail: NTIS HC/MF A03 CSCL 13I

A low friction, object guidance, and gripping finger device for a robotic end effector on a robotic arm is disclosed, having a pair of robotic fingers each having a finger shaft slideably located on a gripper housing attached to the end effector. Each of the robotic fingers has a roller housing attached to the finger shaft. The roller housing has a ball bearing mounted centering roller located at the center, and a pair of ball bearing mounted clamping rollers located on either side of the centering roller. The object has a recess to engage the centering roller and a number of seating ramps for engaging the clamping rollers. The centering roller acts to position and hold the object symmetrically about the centering roller with respect to the X axis and the clamping rollers act to position and hold the object with respect to the Y and Z axis. NASA

**N91-17402*#** Catholic Univ. of America, Washington, DC. Dept. of Electrical Engineering.
**DEVELOPMENT OF ADVANCED CONTROL SCHEMES FOR TELEROBOT MANIPULATORS Final Report, 15 Feb. 1989 - 31 Dec. 1990**
Charles C. Nguyen and Zhen-Lei Zhou Feb. 1991 34 p
(Grant NAG5-1124)
(NASA-CR-184930; NAS 1.26:184930) Avail: NTIS HC/MF A03 CSCL 13H

To study space applications of telerobotics, Goddard Space Flight Center (NASA) has recently built a testbed composed mainly of a pair of redundant slave arms having seven degrees of freedom and a master hand controller system. The mathematical developments required for the computerized simulation study and motion control of the slave arms are presented. The slave arm forward kinematic transformation is presented which is derived using the D-H notation and is then reduced to its most simplified form suitable for real-time control applications. The vector cross product method is then applied to obtain the slave arm Jacobian matrix. Using the developed forward kinematic transformation and quaternions representation of the slave arm end-effector orientation, computer simulation is conducted to evaluate the efficiency of the Jacobian in converting joint velocities into Cartesian velocities and to investigate the accuracy of the Jacobian pseudo-inverse for various sampling times. In addition, the equivalence between Cartesian velocities and quaternion is also verified using computer simulation. The motion control of the slave arm is examined. Three control schemes, the joint-space adaptive control scheme, the Cartesian adaptive control scheme, and the hybrid position/force control scheme are proposed for controlling the motion of the slave arm end-effector. Development of the Cartesian adaptive control scheme is presented and some preliminary results of the remaining control schemes are presented and discussed. Author

**N91-17403*#** Southern Research Inst., Birmingham, AL.
**INVESTIGATION OF WELDING AND BRAZING OF MOLYBDENUM AND TZM ALLOY TUBES Final Report, Nov. 1990 - Feb. 1991**
Wayne E. Lundblad Feb. 1991 35 p
(NASA Order H-080640)
(NASA-CR-187899; NAS 1.26:187899; SRI-MME-91-097-7244)
Avail: NTIS HC/MF A03 CSCL 13H

This effort involved investigating the welding and brazing techniques of molybdenum tubes to be used as cartridges in the crystal growth cartridge. Information is given in the form of charts and photomicrographs. It was found that the recrystallization temperature of molybdenum can be increased by alloying it with 0.5 percent titanium and 0.1 percent zirconium. Recrystallization temperatures for this alloy, known as TZM, become significant around 2500 F. A series of microhardness tests were run on samples of virgin and heat soaked TZM. The test results are given in tabular form. It was concluded that powder metallurgy TZM may be an acceptable cartridge material. Author

**N91-17404#** Argonne National Lab., IL.
**SIMULATION STUDIES OF DIESEL ENGINE PERFORMANCE WITH OXYGEN ENRICHED AIR AND WATER EMULSIFIED FUELS**
D. N. Assanis, D. Baker (Illinois Univ., Urbana.), R. R. Sekar, C. T. Siambekos, R. L. Cole, and T. J. Marciniak 1990 6 p Presented at the 13th Energy-Sources Technology Conference and Exhibition, New Orleans, LA, 14-18 Jan. 1990
(Contract W-31-109-eng-38)
(DE91-006053; CONF-900102-6) Avail: NTIS HC/MF A02

A computer simulation code of a turbocharged, turbocompound diesel engine was modified to study the effects of using oxygen-enriched combustion air and water-emulsified diesel fuels. Oxygen levels of 21 percent to 40 percent by volume in the combustion air were studied. Water content in the fuel was varied from 0 percent to 50 percent mass. Simulation studies and a review and analysis of previous work in this area led to the following conclusions about expected engine performance and emissions: the power density of the engine is significantly increased by oxygen enrichment. Ignition delay and particulate emissions are reduced. Combustion temperatures and No(sub x) emissions are increased with oxygen enrichment but could be brought back to the base levels by introducing water in the fuel. The peak cylinder pressure which increases with the power output level might result in mechanical problems with engine components. Oxygen enrichment also provides an opportunity to use cheaper fuel such as No. 6 diesel fuel. Overall, the adverse effects of oxygen enrichment could be countered by the addition of water and it appears that an optimum combination of water content, oxygen level, and base diesel fuel quality may exist. This could yield improved performance and emissions characteristics compared to a state-of-the-art diesel engine. DOE

**N91-17405#** Oak Ridge National Lab., TN. Metals and Ceramics Div.
**COMPUTATIONAL MODELING OF GTA (GAS TUNGSTEN ARC) WELDING WITH EMPHASIS ON SURFACE TENSION EFFECTS**
T. Zacharia and S. A. David 1990 18 p Presented at the 13th ASME-JSME International Solar Energy Conference, Reno, NV, 17-22 Mar. 1991 Submitted for publication
(Contract DE-AC05-84OR-21400)
(DE91-004771; CONF-910318-12) Avail: NTIS HC/MF A03

A computational study of the convective heat transfer in the weld pool during gas tungsten arch (GTA) welding of Type 304 stainless steel is presented. The solution of the transport equations is based on a control volume approach which utilized directly the integral form of the governing equations. The computational model considers buoyancy and electromagnetic and surface tension forces in the solution of convective heat transfer in the weld pool. In addition, the model treats the weld pool surface as a deformable free surface. The computational model includes weld metal vaporization and temperature dependent thermophysical properties. The results indicate that consideration of weld pool vaporization effects and temperature dependent thermophysical properties significantly influence the weld model predictions. Theoretical predictions of the weld pool surface temperature distributions and the cross-sectional weld pool size and shape were compared with corresponding experimental measurements. Comparison of the theoretically predicted and the experimentally obtained surface temperature profiles indicated agreement with (plus minus) 8 percent. The predicted weld cross-section profiles were found to agree very well with actual weld cross-sections for the best theoretical models. DOE

# 38 QUALITY ASSURANCE AND RELIABILITY

Includes product sampling procedures and techniques; and quality control.

**N91-17406#** Pacific Northwest Lab., Richland, WA.
**A CANDIDATE CONFIGURATION FOR AUTOMATED PROCESS MONITORING**
Roger Hollenbaugh (Army Depot System Command, Chambersburg, PA.) and A. Lynn Franklin Mar. 1990 3 p Presented at the Artificial Intelligence Applications for Military Logistics, Williamsburg, VA, 27-30 Mar. 1990
(Contract DE-AC06-76RL-01830)
(DE90-010991; PNL-SA-18028; CONF-9003157-1) Avail: NTIS HC/MF A01

The concept of total quality management (TQM) embodies a number of significant notions. Among these is the notion of statistical process control (SPC). The U.S. Army Depot System Command (DESCOM) has endorsed the concept of TQM and is actively pursuing the implementation of SPC throughout its organization. One of the difficulties inherent in the applications of SPC to the wide variety of DESCOM processes is the extensive amount of training required to collect process, and interpret the requisite statistical information. To reduce this training demand and to simplify the application of SPC over a broad range of processes, DESCOM is developing a generic automated SPC collection and interpretation system. This system interfaces with individual stages from a large variety of industrial processes to provide automated data storage, presentation, and interpretation. The system is composed of the following six separate modules: process interface module; data storage and presentation module; pattern recognition module; pattern interpretation module; incremental learning module; and user interface module. DOE

**N91-17407*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**HOW MUCH REDUNDANCY: SOME COST CONSIDERATIONS, INCLUDING EXAMPLES FOR SPACECRAFT SYSTEMS**
Ronald C. Suich (California State Univ., Fullerton.) and Richard L. Patterson 1990 24 p Proposed for presentation at the AIChE Summer National Meeting Session on Space Power Systems Technology, San Diego, CA, 19-22 Aug. 1990; sponsored by American Inst. of Chemical Engineers
(Grant NAG3-1100)
(NASA-TM-103197; E-5592; NAS 1.15:103197) Avail: NTIS HC/MF A03 CSCL 14D

How much redundancy should be built into a subsystem such as a space power subsystem. How does a reliability or design engineer choose between a power subsystem with 0.990 reliability and a more costly subsystem with 0.995 reliability. How does the engineer designing a power subsystem for a satellite decide between one power subsystem and a more reliable but heavier power subsystem. High reliability is not necessarily an end in itself. High reliability may be desirable in order to reduce the statistically expected loss due to a subsystem failure. However, this may not be the wisest use of funds since the expected loss due to subsystem failure is not the only cost involved. The subsystem itself may be very costly. The cost of the subsystem or the expected loss due to subsystem failure may not be considered separately. Therefore, the total of the two costs is minimized, i.e., the total of the cost of the subsystem plus the expected loss due to subsystem failure. A specific type of redundant system is considered, called a k-out-of-n: G subsystem. Such a subsystem has n modules, of which k are required to be good for the subsystem to be good. Five models are discussed which can be applied in the design of a power subsystem to select the unique redundancy method which will minimize the total of the cost of the power subsystem plus the expected loss due to the power subsystem failure. A BASIC computer program is available. Author

**N91-17408#** Texas Univ., Arlington. Transportation Instrumentation Lab.
**PAVEMENT CRACK DETECTION WITH LASERS Final Report,**
Roger S. Walker and Chuying Kuo Jan. 1990 80 p Sponsored by Texas State Dept. of Highways and Public Transportation, Austin and Federal Highway Administration, Austin, TX
(PB91-103820; RR-1141-2F) Avail: NTIS HC/MF A05 CSCL 14D

The research effort has involved three stages. The first two stages were to determine the crack detection capabilities of the laser probes, used on the Surface Dynamics Profilometer (SDP). The SDP is owned by the State and used for road profile measurements. After experiments indicated that these probes could be used for such detection, a system was developed to further study this capability and to determine how it could be used to implement an automated high speed crack identification system. The results of the first two stages, and a complete description of the research effort is provided in Research Report 1141-1. The third stage was the development of a system which could be used for implementation of such a system so it's usefulness for P.E.S. data collection activities can be determined. Author

**N91-17409*#** Northwestern Univ., Evanston, IL. Dept. of Mechanical Engineering.
**GENERAL MONTE CARLO RELIABILITY SIMULATION CODE INCLUDING COMMON MODE FAILURES AND HARP FAULT/ERROR-HANDLING Final Report**
M. E. Platt, Elmer E. Lewis, and Franz Boehm (Kernforschungszentrum G.m.b.H., Karlsruhe, Germany, F.R.) Jan. 1991 101 p
(Grants NAG1-1031; AF-AFOSR-0340-84)
(NASA-CR-187793; NAS 1.26:187793) Avail: NTIS HC/MF A06 CSCL 14D

Variance reduction techniques have made it feasible to use of the Monte Carlo method to simulate even large state space governing Markov processes such as those encountered in modeling systems for reliability and/or availability evaluation. The present version of the Monte Carlo program for computing system unreliability effectively uses two variance reduction techniques: forced transitions and failure biasing. The structure of the program differs from earlier versions as it was written to be consistent with the HARP code which employs behavioral decomposition. This enables the impartial demonstration of the Markov Monte Carlo method's capability versus the Runge-Kutte method used in the HARP code to solve the Markov chain in the reliability analysis. The HARP provides several models for system fault/error-handling (FEHM's or coverage models) which are accessible by the Monte Carlo program. In addition to these coverage models, the handling of common mode failures are separately incorporated into the program, and their influence on the overall system unreliability is taken into account. A listing of the program appears in Appendix C. In Appendix D a copy of a previous paper is presented which provides a summary of the work prior to the inclusion of common mode failures into the reliability simulation. Author

**N91-17410#** Drexel Univ., Philadelphia, PA.
**FUNDAMENTAL APPROACH TO SERVICE LIFE PREDICTION OF FLEXIBLE MEMBRANE LINERS (FML'S)**
Arthur E. Lord, Jr. and Robert M. Koerner Aug. 1990 88 p
(Contracts EPA-CR-810977; WP-85060D)
(PB90-263856; EPA/600/2-90/041) Avail: NTIS HC/MF A05 CSCL 14D

The prediction of the service life of flexible membrane liners (FMLs) when exposed to chemicals has usually been by way of testing for physical or mechanical property changes after periodic exposure times. An alternate approach is presented by evaluating the properties via five different mass transport tests: water vapor transmission (WVT), radioactive tracer transmission (RT), water absorption (WA), water vapor absorption (WVA), and benzene absorption (BA). Author

**N91-17411#** California Univ., Davis. Div. of Statistics.
**RELIABILITY MODELING AND INFERENCE FOR COHERENT SYSTEMS SUBJECT TO AGING, SHOCK, OR REPAIR Final Report, 1 Aug. 1988 - 31 Jul. 1990**
Francisco J. Samaniego 31 Aug. 1990 14 p
(Grants AF-AFOSR-0308-88; AF-AFOSR-0159-84; AF Proj. 2304)
(AD-A229262; AFOSR-90-1107TR) Avail: NTIS HC/MF A03 CSCL 12/3

The results obtained in 8 completed manuscripts and two manuscripts in preparation are summarized. This research includes contributions to (1) product moment computation for multivariate survival functions, (2) parametric and nonparametric estimation in reliability, (3) the foundations of statistical estimation theory, and (4) nonstandard sampling techniques in life testing experiments. GRA

**N91-17028*#** National Aeronautics and Space Administration, Washington, DC.
**RELIABILITY AND QUALITY EEE PARTS ISSUES**
Dan Barney and Irwin Feigenbaum (Vitro Corp., Washington, DC.) *In its* Space Transportation Avionics Technology Symposium. Volume 2: Conference Proceedings Aug. 1990 p 247-273 (For primary document see N91-17020 09-06)
Avail: NTIS HC/MF A99 CSCL 09D

**N91-17042*#** National Aeronautics and Space Administration, Washington, DC.
**FLIGHT ELEMENTS: FAULT DETECTION AND FAULT MANAGEMENT**
H. Lum, A. Patterson-Hine, J. T. Edge, and D. Lawler *In its* Space Transportation Avionics Technology Symposium. Volume 2: Conference Proceedings Aug. 1990 p 557-567 (For primary document see N91-17020 09-06)
Avail: NTIS HC/MF A99 CSCL 09D

# 39 STRUCTURAL MECHANICS

Includes structural element design and weight analysis; fatigue; and thermal stress.

For applications see *05 Aircraft Design, Testing and Performance* and *18 Spacecraft Design, Testing and Performance.*

**N91-17412** Michigan Univ., Ann Arbor.
**LIMIT ANALYSIS IN PLANE STRAIN: THE LOWER BOUND APPROACH Ph.D. Thesis**
Wei-Min Chang 1990 227 p
Avail: Univ. Microfilms Order No. DA9023525

A robust algorithm is developed to solve plane strain limit analysis problems by means of the lower bound approach. The theoretical foundation of this algorithm is the duality theorem which connects the classical lower bound and upper bound formulations by equating the least upper bound and the greatest lower bound. Using a suitable linearized yield function and the finite element equilibrium equations of a continuum, the lower bound formulation leads to a linear programming problem. The constraint equations of the problem include the equilibrium equations, the traction boundary conditions, and the linearized yield conditions. To solve the bounded form linear programming, a null-space basis algorithm was developed, which is more effective than the traditional simplex algorithm in many aspects. Adopting the rectangular norm for this algorithm, a new set of variables is introduced by way of a linear transformation, which has the advantage of greatly reducing the number of constraint equations. This technique circumvents the major drawback of the lower bound formulations and solution methods facing other investigators, who had to solve greater number of constraint equations and introduce additional slack or surplus variables. The developed algorithm is then applied to two classes of problems: punch indentation and metal extrusion. Since each of these applications involves extensive variations of the physical and geometrical parameters involved, they can be investigated thoroughly. Thus, some new important results are

obtained for these two problems, e.g., it is possible to do a complete study of the dimensional effects on collapse pressure for the problem of indentation into a block with finite dimensions.
Dissert. Abstr.

**N91-17413** Worcester Polytechnic Inst., MA.
**BOUNDARY EFFECTS, GRAIN-SIZE REDUCTION, AND NORMAL STRESS DIFFERENCES IN RAPID GRANULAR SHEAR FLOWS Ph.D. Thesis**
Chuen-Shii Chou 1990 135 p
Avail: Univ. Microfilms Order No. DA9026042

The rapid flows of identical, smooth, nearly elastic spheres that interact with a flat wall to which identical, evenly spaced half-spheres were attached, is considered. Employing the constitutive relations of Jenkins and Richman (1985a) and boundary conditions of Richman (1988) in the balance equations for mean fields of density, velocity, and the granular temperature, the boundary-value problem is solved for the steady inhomogeneous shear flows maintained by the relative motion of parallel bumpy boundaries. A kinetic theory is developed for homogeneous granular shear flows of identical spheres that experience gradual grain size reduction due to repeated collisions between particles. The theory consists of balance equations for mass, momentum, and energy as well as constitutive relations for the stress, the collisional rate of energy dissipation, and the collisional rate of mass loss. The appearance of the collisional rate of mass loss is the most striking departure of this theory from recent theories for non-comminuting granular materials. Finally, a constitutive theory is developed for steady, homogeneous, granular shear flows of identical, smooth, highly inelastic spheres. In these flows, the important mean fields are the solid fraction, mean velocity, and full second moment of fluctuation velocity. The constitutive theory, which consists of stress tensor and the collisional source of second moment, is based upon an anisotropic Maxwellian velocity distribution function. The constitutive relation for the stress tensor contains contributions from both particle transport and particle collisions and therefore applies to the full range of solid fraction. The constitutive theory is combined with the balance equation for full second moment to determine each component of second moment and stress tensor.
Dissert. Abstr.

**N91-17414#** Ustav Jaderneho Vyzumu, Rez (Czechoslovakia).
**FAILURE CRITERION OF THIN-WALLED TUBES SUBJECTED TO PROPORTIONAL AND NON-PROPORTIONAL LOADING**
J. Novak and D. Lauerova Apr. 1989 17 p
(DE90-638387; UJV-8597-M) Avail: NTIS (US Sales Only)
HC/MF A03

The values are predicted of critical deformation for localized fuel can necking under proportional and nonproportional loads. The theoretical models are assessed of critical deformation relations on the deformation pathway, and constitutive equations are formulated and applied to anisotropic material under a nonproportional load. Bifurcation analysis is performed of localized necking based on improved description of the orthotropic material plasticity area under a proportional load. The results obtained are compared with experiments, and the effect is assessed of the constitutive material description on the predicted critical deformation values. DOE

**N91-17415*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**A METHODOLOGY FOR EVALUATING THE RELIABILITY AND RISK OF STRUCTURES UNDER COMPLEX SERVICE ENVIRONMENTS**
Michael C. Shiao (Sverdrup Technology, Inc., Brook Park, OH.) and Christos C. Chamis Apr. 1990 17 p Presented at the 31st Structures, Structural Dynamics and Materials Conference, Long Beach, CA, 2-4 Apr. 1990; sponsored in part by AIAA, ASME, ASCE, AHS, and ACS Previously announced in IAA as A90-29332
(NASA-TM-103244; E-5669; NAS 1.15:103244) Avail: NTIS
HC/MF A03 CSCL 20K

The theoretical basis and numerical implementation of NESSUS (Numerical Evaluation of Stochastic Structures Under Stress), a computer code for probabilistic structural analysis of aerospace components, are described, with an emphasis on the use of NESSUS for reliability and risk assessment. Topics addressed include the structure of probabilistic models of fatigue-crack initiation, risk/cost evaluation, fatigue-fracture analysis, and fatigue-crack initiation. Numerical results from typical applications are presented in graphs and briefly characterized. The usefulness of NESSUS predictions for establishing inspection and retirement schedules and for component certification is indicated. Author

**N91-17416** Pennsylvania State Univ., University Park.
**FRACTALS AND FRACTURE Ph.D. Thesis**
Thomas James Mackin 1990 192 p
Avail: Univ. Microfilms Order No. DA9032335

Fractal geometry can describe the complex texture of many natural objects, the description being summarized by a key parameter: fractal dimension. In previous work, the fractal dimension of several ceramic fracture surfaces were empirically related to fracture toughness by K(sub IC) is approximately (D - 1)(sup 1/2) where D is the dimension of the contour line of the fracture surface. This equation states that an increase in fractal dimension is accompanied by an increase in fracture toughness. A fractal modification of Griffith's energy balance approach is derived and results in a theoretical relationship between toughness and fractal dimension of the fracture surface. The use of fractal dimensions is investigated as a descriptive parameter in brittle fracture. Several key issues are addressed including the relationship between contour and surface dimensions, a derivation of the fractal Griffith equation, an experimental investigation of dimension as a function of flaw-to-grain size ratio, and the derivation of Richardson's equation. Contour dimensions are shown to be one less than surface dimensions while no such relation holds for profile dimensions. Furthermore, the contour dimensions will remain the same at various altitudes through the fracture surface. A change in the angle of the cutting plane does alter the measured dimension, but does not do so until a critical angle is reached. The critical angle will depend upon the dimension of the surface; lower dimensional surfaces having smaller critical angles than high dimensional surfaces. The fractal dimension of the fracture surfaces of ZnS are found to follow the same flaw-to-grain-size behavior as the corresponding fracture toughness. Finally, the fractal Griffith equation explains the single-to-polycrystalline fracture transitions that are noted in the experimental results. Dissert. Abstr.

**N91-17417** Northwestern Univ., Evanston, IL.
**EFFICIENT ALLOCATION OF COMPUTATIONAL RESOURCES FOR FINITE ELEMENT APPLICATIONS Ph.D. Thesis**
Edward John Plaskacz 1990 188 p
Avail: Univ. Microfilms Order No. DA9031977

Adaptive finite element analysis and finite element analysis on the Connection machine, a massively parallel SIMD computer are examined. Both topics focus on efficient allocation of computational resources but in different environments. Whereas the thrust of the adaptive algorithm is towards achieving the best solution with a specified amount of computer resources in a SISD environment through h-method reallocation, the parallel algorithm seeks to attain peak performance in a SIMD environment through a computation versus communication tradeoff. The adaptive procedure is developed for the transient analysis of nonlinear shells. The scheme is an h-method which employs fission and fusion of elements to adaptively refine and coarsen the mesh. Incremental work and deviation of the bilinear finite element approximation to the shell from a Kirchoff-Love surface are used as error criteria for adaptivity. The adaptation of a finite element program with explicit time integration to a massively parallel SIMD computer, the Connection machine, required the standard gather and assembly to be replaced by an exchange of nodal forces at each time step. In addition, the data were reconfigured so that all nodal variables associated with an element are stored in a processor along with other element data. Various alternate data structures and associated algorithms for nonlinear finite element analysis are discussed and compared. The implementation of an explicit

transient program for the three-dimensional nonlinear finite element analysis of shells on the Connection machine is described. Particular emphasis is placed on interprocessor communication using router and NEWS schemes. A hybrid communication scheme, where NEWS is used within structured subdomains and the router is used to exchange nodal forces between subdomains is examined. Dissert. Abstr.

**N91-17418#** Sydney Univ. (Australia). School of Civil and Mining Engineering.
**WIND TUNNEL TEST OF WIND LOADS ON VARIOUS SHAPES OF ELEVATED BUILDINGS FOR ANTARCTIC USE**
K. H. Kim, K. C. S. Kwok, and H. F. Rohde (University of Technology, Sydney, Australia ) Mar. 1990 42 p
(PB90-259318; R-608) Avail: NTIS HC/MF A03 CSCL 20K

The wind tunnel study is described which evaluated the wind-induced loads on elevated buildings designed for Antarctic use. A 1/50 scale boundary layer wind model over a terrain category 2 was generated. A force balance was used to measure the horizontal and vertical forces on building models. Mean drag, drag r.m.s., mean lift, and lift r.m.s. coefficients of the models are presented for different building configurations and wind angles. Author

**N91-17419#** Transportation Systems Center, Cambridge, MA. Inst. of Fracture and Solid Mechanics.
**EVALUATION OF ELBER'S CRACK CLOSURE MODEL AS AN EXPLANATION OF TRAIN LOAD SEQUENCE EFFECTS ON CRACK GROWTH RATES Final Report**
D. Y. Jeong and G. C. Sih (Lehigh Univ., Bethlehem, PA.) Jun. 1990 29 p Sponsored by Federal Railroad Administration
(PB90-268624; DOT-TSC-FRA-90-1; DOT/FRA/ORD-90/06)
Avail: NTIS HC/MF A03 CSCL 20K

Elber's crack closure model is studied in relation to the results of lab spectrum crack growth tests on compact tension specimens (CTS) fabricated from rail steel. Comparison of model predictions with test results for crack growth life is effected by means of an analysis of a center cracked panel (CCP) subjected to an equivalent stress spectrum. (The model cannot be directly applied to the CTS because it is numerically unstable when supplied with finite element approximations for the elastic displacement field at the plastic zone boundary). The trends of the model predictions and test results agree as to the effect of changing cycle order in the spectrum, but the actual effect on crack growth life in the lab test is found to be much stronger than the effect predicted by Elber's model. Author

**N91-17420** Virginia Polytechnic Inst. and State Univ., Blacksburg.
**NONLINEAR FLEXURAL-FLEXURAL-TORSIONAL DYNAMICS OF METALLIC AND COMPOSITE BEAMS Ph.D. Thesis**
Perng-Jin Frank Pai 1990 308 p
Avail: Univ. Microfilms Order No. DA9028074

A combination of Newton's second law, a transformation using three consecutive Euler angles, and Taylor expansions is used to develop three nonlinear integro-differential equations describing the flexural-flexural-torsional vibration of metallic and composite beams. A combination of the fundamental-matrix method and the method of multiple scales is used to construct a set of nonlinear autonomous first-order ordinary differential equations describing the slow time modulation of the amplitudes and phases of the interacting modes in the presence of one to one and/or two to one internal resonances. The inversion symmetry, D sub 4 symmetry, and O(2) symmetry of the system are studied using the modulation equations. The solutions of the modulation equations may be fixed points, limit cycles, or chaotic solutions. The frequency and amplitude of excitation are used as bifurcation parameters. A fixed point is found to lose stability in either a saddle node bifurcation or a Hopf bifurcation. Limit cycle and their periods are located using a shooting technique coupled with a Newton-Raphson iteration method. The stability of a limit cycle is studied using Floquet theory. Dissert. Abstr.

**N91-17421** Clemson Univ., SC.
**ANALYSIS OF THE INTERLAMINAR STRESS COMPONENTS AT THE SKIN/STIFFENER INTERFACE OF AN ADVANCED-CONCEPT STIFFENED PANEL Ph.D. Thesis**
Jacobus Frederikus M Wiggenraad 1990 225 p
Avail: Univ. Microfilms Order No. DA9033434

A grid-stiffened panel of fiber-reinforced composite material with a laminated skin and stiffeners of unidirectional material is investigated. The stiffeners are joined to the skin by a laminate which forms a wrap around the stiffeners. A numerical analysis of the interlaminar stress state at the interfaces of skin, stiffener, and wrap is presented. The influence of design parameters is evaluated. A procedure was developed to generate a finite element model of a generic grid-stiffened panel using shell elements, named Global Model. This procedure was used to design a grid-stiffened wing panel that satisfied specified design criteria, and to obtain its displacements at the design load via a nonlinear analysis. A second procedure was developed to generate a generic finite element model of a detailed skin-stiffener combination, utilizing three-dimensional finite elements, named Local Model. The interlaminar stress components were determined with the Local Model by applying displacements obtained previously with the Global Model. Author

**N91-17422** California Univ., Santa Barbara.
**IMPROVED APPROXIMATIONS FOR STATIC STRESS CONSTRAINTS IN SHAPE OPTIMAL DESIGN OF SHELL STRUCTURES Ph.D. Thesis**
Gregory James Moore 1990 112 p
Avail: Univ. Microfilms Order No. DA9034336

The Force Approximation Method was applied to the shape optimal design of plate and shell structures subject to static stress constraints. The force approximation of static stress constraints is first developed within the context of structural design synthesis. The improved accuracy of approximation is based on Taylor series expansion of its component terms. It confirms the included computational results and proposes alternative methods for applying the Force Approximation Method in general. The computational examples test the Force Approximation's performance characteristics under a variety of circumstances and compare it with other approaches. It is concluded that the shape optimal design of stress constrained shell structures is enhanced through the use of Force Approximations as was observed for other structures. However, in all cases, the direct application of the method incurs an unnecessary computational burden. Dissert. Abstr.

**N91-17423** Purdue Univ., West Lafayette, IN.
**GEOMETRICALLY NONLINEAR RANDOM VIBRATIONS OF STRUCTURES Ph.D. Thesis**
Chih-Tsai Chen 1990 149 p
Avail: Univ. Microfilms Order No. DA9031307

A finite element formulation combined with stochastic linearization and normal mode methods, including geometrical nonlinearity, are presented for the study of the random vibration responses of beam, frame, plate (isotropic as well as composite), and shell structures subjected to simultaneously spatial and temporal Gaussian stationary nonwhite and nonzero mean random excitations. Six degrees-of-freedom beam and frame elements and forty-eight degrees-of-freedom quadrilateral thin shell element (including the plate version) are used in this study. Examples include: dynamic random responses of simply supported beams, clamped-clamped beams, a simply supported beam on an elastic foundation, a fixed-end portal frame, a simply supported square plate, a clamped square plate, a cylindrical panel with all edges supported by rigid diaphragms, a clamped spherical cap, a double-curved panel, and a simply supported specially orthotropic laminated square plate. Other examples presented include: a simply supported (0 degree/90 degrees)s laminated square plate, a simply supported anti-symmetric angle-ply (theta/-theta) laminated square plate, a simply supported (+/- 45 degrees/90 degrees/0 degrees)s laminated anisotropic square plate, and a simply supported (45 degrees (sub 2)/0 degrees)s laminated anisotropic square plate

subjected to different random loadings. The Monte Carlo simulation method is used to generate solutions to compare with some of the present results when alternative solutions are not available. Some linear analytical solutions of simply supported beam and plate under nonwhite and nonzero mean loadings are also derived for comparison. Some linear and nonlinear analytical solutions of simply supported laminated composite plate are also obtained for comparison based on the formulation of isotropic plate.
Dissert. Abstr.

**N91-17424** California Inst. of Tech., Pasadena.
**AN EXPERIMENTAL INVESTIGATION OF MODE-I CRACK TIP DEFORMATION Ph.D. Thesis**
Peter D. Washabaugh 1990 108 p
Avail: Univ. Microfilms Order No. DA9031496

The out-of-plane displacement of amorphous polymethylmethacrylate plates rupturing at slow (0.1 mm/s), and fast (0.5 to 0.9 mm/microsec) rates are measured using a Twymann-Green interferometer. The measured surface shapes within one plate thickness of the crack-tip do not compare well with the two-dimensional planar asymptotic approximation, but compare favorably with the published slopes for three-dimensional finite element solutions when normalized with the static material properties. Discrepancies, on the order of ten percent, between the magnitude of the three-dimensional finite element solutions suggest that the stress intensity factor does not fully characterize the near tip deformations. A dynamically propagating crack is found to move in a non-steady, periodic, sub-microsecond fashion. This result is supported both by the surface measurements and the fracture morphology. The material toughening, as measured by the surface roughness, correlates well with the stress intensity factor and not with the crack velocity. The details of the sub-microsecond propagation and toughening were not resolvable with the microsecond temporal resolution of the experiment. Inhibiting the material toughening at the crack tip by artificially introducing a weak material plane augments the crack motion to velocities close to the material's shear wave speed. The crack propagates more steadily along the weak plane than through a virgin solid, while maintaining the character of the out-of-plane displacement of a crack propagating in an unsullied material.
Dissert. Abstr.

**N91-17425** Cincinnati Univ., OH.
**A STUDY IN STRESS CONCENTRATION OPTIMIZATION USING BOUNDARY ELEMENT METHODS Ph.D. Thesis**
Richard Earl Dippery, Jr. 1990 181 p
Avail: Univ. Microfilms Order No. DA9032618

Notches or holes of incorrect shape, size, or orientation are known contributors to premature mechanical failure of mechanical components. For a uniaxially loaded plate with a hole in the center, the stress concentration of the hole can be reduced if smaller holes are placed on each side of the primary hole. Handbooks do not state where to locate or what size to make secondary holes to maximize stress reduction. Here, current gradient based optimization techniques are combined with the boundary element method to solve the hole/notch location and size problem. Examples are used to demonstrate the application of this technique.
Dissert. Abstr.

**N91-17426** Michigan Technological Univ., Houghton.
**AN INDIRECT BOUNDARY ELEMENT METHOD FOR ISOTROPIC AND ORTHOTROPIC PLATES Ph.D. Thesis**
Yikang Zhang 1989 267 p
Avail: Univ. Microfilms Order No. DA9033298

An indirect boundary element method is presented for analyzing isotropic and orthotropic plates. The integral equation formulation is based on the fundamental solutions and the superposition principle. The boundary element method starts with the statement of the problem in terms of an integral equation. The integrand in the integral equation is a product of the fundamental solution and an unknown function. The order of continuity that the unknown function must satisfy depends upon the order of singularity in the fundamental solution. It is verified that the second order singularity presented in the fundamental solution requires the continuity of the first derivative of the unknown function. The continuity requirement can be met by using Hermite polynomials. A limited comparison is made on the use of the Lagrange and Hermite polynomials. Discretization of the problem results in boundary integrals over straight line segments. An iterative technique is used for analytical evaluation of the boundary integrals. The transverse distributed load is incorporated into the formulation through domain integrals. The domain integrals are transformed to line integrals by the divergence theorem, and evaluated by a similar mean as for the boundary integrals. For orthotropic plates, the fundamental solutions in more more general form are developed by using the Fourier transform and complex variable calculus. Unlike isotropic materials, there are three forms of fundamental solutions for orthotropic plates. The structure in the three forms of the fundamental solutions is identified, and expressed by real and complex variables for different interests. The ideas for solving the isotropic plate problems are directly applied or modified to orthotropic plates. Transversely isotropic and isotropic material behavior is simulated in the test problems.
Dissert. Abstr.

**N91-17427*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**CURRENT ACTIVITIES IN STANDARDIZATION OF HIGH-TEMPERATURE, LOW-CYCLE-FATIGUE TESTING TECHNIQUES IN THE UNITED STATES**
Michael J. Verrilli, J. Rodney Ellis, and Robert W. Swindeman (Oak Ridge National Lab., TN.) 1990 21 p Presented at the Harmonisation of Testing Practice for High Temperature Materials, Ispra, Italy, 18-19 Oct. 1990
(NASA-TM-103675; E-5891; NAS 1.15:103675) Avail: NTIS HC/MF A03 CSCL 20K

The American Society for Testing and Materials (ASTM) standard E606-80 is the most often used recommended testing practice for low-cycle-fatigue (LCF) testing in the United States. The standard was first adopted in 1977 for LCF testing at room temperature and was modified in 1980 to include high-temperature testing practices. Current activity within ASTM is aimed at extending the E606-80 recommended practices to LCF under thermo-mechanical conditions, LCF in high-pressure hydrogen, and LCF in metal-matrix composite materials. Interlaboratory testing programs conducted to generate a technical base for modifying E606-80 for the aforementioned LCF test types are discussed.
Author

**N91-17428*#** McDonnell-Douglas Helicopter Co., Mesa, AZ.
**FINITE ELEMENT MODELING OF THE HIGHER HARMONIC CONTROLLED OH-6A HELICOPTER AIRFRAME**
Douglas Ferg and Mostafa Toossi Oct. 1990 66 p
(Contract NAS1-17498)
(NASA-CR-187449; NAS 1.26:187449) Avail: NTIS HC/MF A04 CSCL 20K

An MSC/NASTRAN finite element model of the higher harmonic control configured OH-6A helicopter fuselage was developed. This finite element model was verified by performing various model checkouts and correlation with results from a ground vibration test.
Author

**N91-17429*#** North Carolina Univ., Raleigh. Dept. of Mechanical and Aerospace Engineering.
**SHEAR BUCKLING OF SPECIALLY ORTHOTROPIC PLATES WITH CENTRALLY LOCATED CUTOUTS Semiannual Report**
Eric C. Klang Feb. 1991 20 p
(Grant NAG1-917)
(NASA-CR-187894; NAS 1.26:187894) Avail: NTIS HC/MF A03 CSCL 20K

There is significant industry demand for a method of analyzing the shear buckling of composite plates with cutouts. This method should be able to easily accommodate frequent changes in model design; inflexibility being the major drawback to current finite element methods. The approach taken here is broken into two problems, prebuckling and buckling. To solve for the prebuckling stresses, complex variable equations are used in conjunction with

boundary collocation. The least squares approach is utilized to improve the accuracy of the results. The buckling problem is solved using the Ritz method. A product of the Ritz method is a complicated integral equation which is solved using numerical integration. To date, the aforementioned method of determining the prebuckling stresses was verified against infinite plate theory and finite elements. Recent efforts have focused on reducing run time, improving accuracy and adding more boundary condition choices. Author

**N91-17430#** Army Materials Technology Lab., Watertown, MA. Mechanics and Structures Branch.
**A COMPUTATIONAL AND EXPERIMENTAL INVESTIGATION OF MODE I FRACTURE IN AN ELASTOMER M.S. Thesis - Massachusetts Inst. of Technology, 1990 Final Report**
Claudia J. Quigley Sep. 1990 228 p Sponsored by Army Lab. Command, Adelphi, MD
(AD-A228958; MTL-TR-90-46) Avail: NTIS HC/MF A11 CSCL 11/10

A thickness effect was identified in the Mode I fracture of incompressible hyperelastic materials. The plane strain mechanical crack tip field was examined under the assumptions of small scale nonlinearity using the finite element method. The effect of the constitutive law on the numerical results was determined by using two different invariants of the Rivlin constitutive model: the Mooney-Rivlin law and the third order invariant. Crack tip field quantities from both constitutive laws agreed with the nonlinear asymptotic solution for this problem, although the region of dominance was small. The nature of the nonlinear crack tip zone was characterized both geometrically and kinematically. GRA

**N91-17431#** Westinghouse Savannah River Co., Aiken, SC.
**REFLECTIONAL TRANSFORMATION FOR STRUCTURAL STIFFNESS**
Kiran M. Vashi 1990 4 p Presented at the 7th Annual W Computer Symposium, Pittsburgh, PA, Oct. - Nov. 1990
(Contract DE-AC09-89SR-18035)
(DE91-005680; WSRC-MS-90-184; CONF-9010256-3) Avail: NTIS HC/MF A01

This paper presents a structural reflection-related transformation for structural stiffness. The stiffness transformation addresses reflection of a structure about any of the three coordinate planes and renders the desired stiffness matrix using a stiffness matrix for the same structure before reflection. This transformation is elegant and simple, provides an efficient and technically rigorous approach to derive the required stiffness matrix without structural remodeling, and can be readily programmed to quickly perform the required matrix manipulations. DOE

**N91-17432*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
**SPACE STATION FREEDOM: DYNAMIC INSTRUMENTATION FOR A LARGE SPACE STRUCTURE**
John P. Raney, Paul A. Cooper, and James W. Johnson Dec. 1990 44 p Presented at the 4th NASA/DoD CSI Conference, Orlando, FL, 5-7 Nov. 1990
(NASA-TM-102711; NAS 1.15:102711) Avail: NTIS HC/MF A03 CSCL 20K

A proposed approach called Modal Identification Experiment (MIE) for obtaining on-orbit dynamic response measurements on Space Station Freedom, the first of a family of large, flexible space structures is discussed. The Phase 2 conceptual design study which provides a conceptual design of a proposed measurement system and an experimental protocol for inobstrusively collecting dynamic response data critical to characterizing important vibration modes of Space Station Freedom were recently concluded. The case for conducting such a measurement program is presented and the specific MIE objectives that were identified, are listed. The sequence of discrete Space Station Freedom assembly configurations is described, and the Phase 2 conceptual design of the experiment and instrumentation system are defined. In addition, a plan to utilize a space station hydrid scale model in laboratory simulations as part of the design process are discussed. Author

**N91-17433*#** National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.
**THERMAL BEHAVIOR OF A TITANIUM HONEYCOMB-CORE SANDWICH PANEL**
William L. Ko and Raymond H. Jackson Jan. 1991 13 p
(NASA-TM-101732; H-1661; NAS 1.15:101732) Avail: NTIS HC/MF A03 CSCL 20K

Finite element thermal stress analysis was performed on a rectangular titanium honecomb-core sandwich panel which is subjected to thermal load with a temperature gradient across its depth. The distributions of normal stresses in the face sheets and the face-sheet/sandwich-core interfacial shear stresses are presented. The thermal buckling of the heated face sheet was analyzed by assuming the face sheet to be resting on an elastic foundation representing the sandwich core. Thermal buckling curves and thermal buckling load surface are presented for setting the limit for temperature gradient across the panel depth. Author

# 42 GEOSCIENCES (GENERAL)

**N91-17434*#** Wisconsin Univ., Madison. Space Science and Engineering Center.
**AN INVENTORY OF FOUR-DIMENSIONAL DATA SETS FOR THE EARTH SCIENCES**
Terri Gregory Feb. 1989 227 p
(Contract NAS8-36292)
(NASA-CR-184082; NAS 1.26:184082) Avail: NTIS HC/MF A11 CSCL 08E

The wide variety of data available to the diligent researcher and the myriad paths to obtaining it are emphasized. This inventory is an attempt to make accessible much of the four-dimensional data available in the world. In this quick-look catalog are listed separate data sets (Data Sets sections), sources of data including centers and large data bases (Sources section), and some data expected to be available in the future (Future Data section). In the Data Sets section, individual data sets are arranged alphabetically by institution, with those archived in the U.S.A. listed first, followed by those found elsewhere. The Sources section includes large data bases, centers, and directories. Sources are arranged alphabetically by country. This section is followed by a Future Data section which is a collection of data sets, experiments, and other future developments of which we are cognizant. A collection of further information and order blanks provided by some of the archiving institutions are presented in the appendix.
Author

# 43 EARTH RESOURCES AND REMOTE SENSING

Includes remote sensing of earth resources by aircraft and spacecraft; photogrammetry; and aerial photography.

For instrumentation see *35 Instrumentation and Photography.*

**N91-17435#** National Oceanic and Atmospheric Administration, Boulder, CO. Wave Propagation Lab.
**REPORT ON THE WORKSHOP: APPLICATIONS OF OCEAN ACOUSTIC REMOTE SENSING TO CLIMATE MONITORING**
T. M. Georges and D. R. Palmer Sep. 1990 13 p Workshop held in Boulder, CO, 7-8 Jun. 1990
(PB91-105981; NOAA-TM-ERL-WPL-185) Avail: NTIS HC/MF A03 CSCL 08C

The focus of the workshop is on acoustic propagation modeling and experiment simulation. Broader questions are discussed as well, including climatic needs for monitoring ocean variability and the suitability of ocean acoustics for doing so. The principal

discussion results and conclusions are given. The discussion topics are as follows: (1) relevance to climate studies; (2) the Heard Island Project; (3) propagation modeling -- theory; (4) interpreting acoustic measurements; and (5) experiment simulation. GRA

**N91-17436** Tennessee Univ., Knoxville.
**REMOTE SENSING OF TURBULENCE USING DOPPLER LIDAR AND RADAR TECHNIQUES Ph.D. Thesis**
Dennis Allen Faulkner 1990 128 p
Avail: Univ. Microfilms Order No. DA9030704

The idea of remotely sensing turbulence is not a new idea but has not been achieved to any level of reliability. Severe weather patterns are easy to spot with both Doppler and conventional radar systems. The clear air and otherwise undistinguishable turbulence is the type that has been receiving a lot of publicity lately due to the number of personal injuries suffered aboard the aircraft. The phenomenology and feasibility of remotely sensing and measuring small scale turbulence of this type is investigated. The remote sensing device of particular interest in this effort is the lidar. Data from two different field programs were used to research this effort. Some data were also reduced from a radar experiment conducted out west as a proof of concept. Wind fields were measured with ground based NASA Marshall Space Flight Center (NASA/MSFC), Huntsville, Alabama, lidar; NOAA Wave Propagation Laboratory (NOAA/WPL), Boulder Colorado, lidar; Stapleton International Airport, Denver, Colorado, Doppler radars; and with a NASA B-57B instrumented aircraft. The remotely sensed winds are compared in all cases with the in-situ aircraft measurement. Turbulence intensities measured by computing the lidar wind time history for each range gate and then calculating the rms value relative to the mean agree quite well with the aircraft intensities. Overall, the results of the research show general agreement between winds measured with Doppler lidars/radars and the B-57 instrumented aircraft. Dissert. Abstr.

**N91-17437*#** Georgia Univ., Griffin. Dept. of Agronomy.
**COMPARISON OF GROUND AND SATELLITE BASED MEASUREMENTS OF THE FRACTION OF PHOTOSYNTHETICALLY ACTIVE RADIATION INTERCEPTED BY TALL-GRASS PRAIRIE**
T. H. Demetriades-Shah, E. T. Kanemasu, I. Flitcroft, and H. Su (Kansas State Univ., Manhattan.) 1991 17 p
(Grant NAG5-389)
(NASA-CR-185476; NAS 1.26:185476) Avail: NTIS HC/MF A03 CSCL 02F

The fraction, of photosynthetically active radiation intercepted by vegetation, F(sub ipar) is an important parameter for modeling the interactions between the land-surface and atmosphere and for estimating vegetation biomass productivity. This study was; therefore, an integral part of FIFE. The specific purpose of this experiment was to find out how well definitive measurements of F(sub ipar) on the ground relate to near-ground and satellite based spectral reflectance measurements. Concurrent measurements of F(sub ipar) and ground, helicopter, and satellite based reflectance measurements were taken at thirteen tall-grass prairie sites within the FIFE experimental area. The sites were subjected to various combinations of burning and grazing managements. The ground and helicopter based reflectance measurements were taken on the same day or few days from the time of the overpass of LANDSAT and SPOT satellites. Ground-based reflectance measurements and sun photometer readings taken at the times of the satellite overpasses were used to correct for atmospheric attenuation. Hand-held radiometer spectral indices were strongly correlated with helicopter and satellite based values ($r=0.94$ for helicopter, 0.93 for LANDSAT Thematic Mapper, and 0.86 for SPOT). However, the ground, helicopter, and satellite based normalized difference spectral vegetation indices showed low sensitivity to changes in F(sub ipar). Reflectance measurements were only moderately well correlated with measurements of F(sub ipar) ($r=0.82$ for hand-held radiometer, 0.84 for helicopter measurements, and 0.75 for the LANDSAT Thematic Mapper and SPOT). Improved spectral indices which can compensate for site differences are needed in order to monitor F(sub ipar) more reliably. Author

**N91-17438*#** Purdue Univ., West Lafayette, IN. Lab. for Applications of Remote Sensing.
**NASA APPLICATIONS PROJECT IN MIAMI COUNTY, INDIANA Progress Report**
Chris J. Johannsen, R. Norberto Fernandez, and D. Fabian Lozano-Garcia Jun. 1990 62 p
(Grant NAGw-1472)
(NASA-CR-187916; NAS 1.26:187916; LARS-CR-012391) Avail: NTIS HC/MF A04 CSCL 08B

This project was designed to acquaint county government officials and their clientele with remote sensing and geographic information systems (GIS) products that contain information about land conditions and land use. The specific project objectives are: (1) to investigate the feasibility of using remotely sensed data to identify and quantify specific land cover categories and conditions for purposes of tax assessment, cropland area measurements, and land use evaluation; (2) to evaluate the use of remotely sensed data to assess soil resources and conditions which affect productivity; (3) to investigate the use of satellite remote sensing data as an aid in assessing soil management practices; and (4) to evaluate the market potential of products derived from the above projects. Author

# 44 ENERGY PRODUCTION AND CONVERSION

Includes specific energy conversion systems, e.g., fuel cells; global sources of energy; geophysical conversion; and windpower.

For related information see also *07 Aircraft Propulsion and Power, 20 Spacecraft Propulsion and Power,* and *28 Propellants and Fuels.*

**N91-17439#** Technion - Israel Inst. of Tech., Haifa. Faculty of Mechanical Engineering.
**SIMULATION AND ANALYSIS OF HIGH EFFICIENCY ABSORPTION SYSTEMS FOR SOLAR COOLING, PHASE 2 Final Report**
Arthur Shavit, Ilan Haim, I. Borde, and M. Jelinek (Ben Gurion Univ. of the Negev, Beersheva, Israel ) 31 May 1989 69 p
Sponsored by Israel Ministry of Energy and Infrastructure
(Contract DE-GI03-85SF-15894)
(DE90-010964; DOE/SF-15894/T1-PHASE-2) Avail: NTIS HC/MF A04

A flexible modular computer code was developed for simulation of absorption systems. The code is capable to investigate, on a comparable basis, various cycles configurations with a variety of working fluids. In Phase 1 of the program, two open cycle absorption systems for solar energy were successfully simulated. Modifications which were applied to the code in Phase 2, allowed the analysis of systems with volatile absorbents, as used in advanced, high COP, absorption systems such as the GAX cycle. Ammonia-water database was developed into equation form and introduced to the code. That eliminated discontinuities in evaluating differentials used in the solver. Properties calculated with these equations fit well the tabulated data. This and other modifications allowed to model absorption cycles using ammonia-water. Single effect cycles converged in most ranges. Direct analysis of the code to advanced cycles, such as GAX, still encountered some convergence problems. It was, however, possible to analyze the GAX cycle in groups. The results show that high COP's are obtainable and are compatible with those reached by LBL. The properties of two additional pairs, that were developed in BG Univ., are reported. DOE

**N91-17440** New South Wales Univ., Canberra (Australia).
**LIGHT TRAPPING AND REFLECTION CONTROL IN A CRYSTALLINE SILICON SOLAR CELL Ph.D. Thesis, Jun.**

**1989 Abstract Only**
Patrick Ross Campbell 16 Jul. 1990 2 p
Avail: Issuing Activity

The crystalline silicone (xSi) solar cell has become a competitive supplier of electrical power in remote applications. More widespread use can only be expected with a dramatic reduction in unit cost and further improvement in energy conversion efficiency. The new generation of thin film xSi cells, designed to minimize consumption of expensive hyperpure silicon and with potential for particularly high open-circuit voltage, may be limited in its capacity to absorp the red end of the spectrum. Techniques aimed at improving absorption by extending the pathlength (light trapping) and reducing back surface absorption of these weakly absorbed wavelengths are examined. Ways of reducing top surface reflection, of relevance at all wavelengths, are also studied. Some early light trapping schemes are noted and used to identify the main processes of ray scatter. A review and development of light trapping in the idealized randomizing cell is presented, later used in the analysis of real cell designs. The (111) orientations exposed by an anisotropic etch of a (100) xSi surface are examined for their light trapping properties, as well as their capacity to reduce reflection from the top surface. Combining tilted (111) top surface facets under an encapsulant with a planar back surface reflector is studied for it superior properties in both respects. Author

**N91-17441#** Hawaii Natural Energy Inst., Honolulu.
**HYDROGEN FROM RENEWABLE RESOURCES RESEARCH Annual Report**
Patrick K. Takahashi and Kelton R. McKinley Jul. 1990 70 p
Prepared in cooperation with Midwest Research Inst., Golden, CO
(Contract DE-AC02-83CH-10098)
(DE91-005038; HNEI-90-1026) Avail: NTIS HC/MF A04

In 1986 the Hawaii Natural Energy Institute (HNEI) and the Florida Solar Energy Center (FSEC) were contracted by the Solar Energy Research Institute (SERI) to conduct an assessment of hydrogen production technologies and economic feasibilities of the production and use of hydrogen from renewable resources. In the 1989/90 period all monies were directed toward research and development with an emphasis on integration of tasks, focusing on two important issues, production and storage. The current year's efforts consisted of four tasks, one task containing three subtasks: Hydrogen Production by Gasification of Glucose and Wet Biomass in Supercritical Water; Photoelectrochemical Production of Hydrogen; Photoemission and Photoluminescence Studies of Catalyzed Photoelectrode Surfaces for Hydrogen Production; Solar Energy Chemical Conversion by Means of Photoelectrochemical (PEC) Methods Using Coated Silicon Electrodes; Assessment of Impedance Spectroscopy Methods for Evaluation of Semiconductor-Electrolyte Interfaces; Solar Energy Conversion with Cyanobacteria; and Nonclassical Polyhydride Metal Complexes as Hydrogen Storage Materials. DOE

**N91-17442#** Central Research Inst. of Electric Power Industry, Tokyo (Japan).
**SOLID OXIDE FUEL CELLS: PRODUCING ZIRCONIA SOLID ELECTROLYTE THIN FILMS BY DOCTOR BLADE METHOD**
M. Mori and C. Asakawa Feb. 1990 37 p In JAPANESE; ENGLISH summary
(DE91-736730; CRIE-W-89028) Avail: NTIS HC/MF A03

Planer solid oxide fuel cells (SOFC) have attracted much attention for large power plants with high efficiency and high power density. At present, SOFC is usually fabricated by using high cost electrochemical vapor deposition. An attempt to produce the planer SOFC by the doctor blade method, which is easier and less expensive than electrochemical vapor deposition, was made. This report describes the good fabricating conditions of a zirconia thin film. Its characteristics were examined and the following results were obtained: (1) electrical conductivity of the sintered film was the same as that of a dense zirconia pellet; (2) no gas-cross was observed through the sintered film; and (3) the single cell showed high performance. DOE

**N91-17443#** New Mexico State Univ., Las Cruces. Southwest Technology Development Inst.
**SOUTHERN NEW MEXICO LOW TEMPERATURE GEOTHERMAL RESOURCE ECONOMIC ANALYSIS Final Report**
Carol L. Fischer, Jack Whittier, James C. Witcher, and Rudi Schoenmackers Aug. 1990 112 p
(PB91-105353; NMRDI-2-78-5202/II) Avail: NTIS HC/MF A06 CSCL 10B

An economic evaluation of three low-temperature geothermal sites in New Mexico were performed. A hypothetical geothermal system was designed to supply sufficient energy to satisfy thermal loads for one, four, ten, and fifteen acre commercial greenhouses. Geothermal sites were evaluated to identify the important infrastructure requirements. Capital and operating costs were estimated. Annual levelized costs were calculated for the provision of hot water and fresh water for each site. Geothermal costs were compared with annual levelized costs for a natural gas system to supply the equivalent thermal load. Calculated results indicate that geothermal systems may be competitive with natural gas for larger installations. It is not economically attractive to develop a small geothermal system because the initial capital costs are not recovered with reduced operating costs, relative to natural gas. GRA

**N91-17444*#** Alabama Univ., Huntsville. Dept. of Electrical and Computer Engineering.
**COMPUTER MODELING OF INVERSION LAYER MOS SOLAR CELLS AND ARRAYS Final Technical Progress Report, 31 Dec. 1989 - 30 Jun. 1990**
Fat Duen Ho 15 Feb. 1991 75 p
(Grant NAG8-083)
(NASA-CR-187875; NAS 1.26:187875) Avail: NTIS HC/MF A04 CSCL 10A

A two dimensional numerical model of the inversion layer metal insulator semiconductor (IL/MIS) solar cell is proposed by using the finite element method. The two-dimensional current flow in the device is taken into account in this model. The electrostatic potential distribution, the electron concentration distribution, and the hole concentration distribution for different terminal voltages are simulated. The results of simple calculation are presented. The existing problems for this model are addressed. Future work is proposed. The MIS structures are studied and some of the results are reported. Author

**N91-17445*#** Oak Ridge National Lab., TN. Metals and Ceramics Div.
**METALLIC PHASE-CHANGE MATERIALS FOR SOLAR DYNAMIC ENERGY STORAGE SYSTEMS**
R. J. Lauf and C. Hamby, Jr. Dec. 1990 41 p
(Contract NASA Order C-30003-J; DE-AC05-84OR-21400)
(NASA-CR-187888; NAS 1.26:187888; ORNL/TM-11351) Avail: NTIS HC/MF A03 CSCL 10A

Solar (thermal) dynamic power systems for satellites require a heat storage system that is capable of operating the engine during eclipse. The conventional approach to this thermal storage problem is to use the latent heat of fluoride salts, which would melt during insolation and freeze during eclipse. Although candidate fluorides have large heats of fusion per unit mass, their poor thermal conductivity limits the rate at which energy can be transferred to and from the storage device. System performance is further limited by the high parasitic mass of the superalloy canisters needed to contain the salt. A new thermal storage system is described in which the phase-change material (PCM) is a metal (typically germanium) contained in modular graphite canisters. These modules exhibit good thermal conductivity and low parasitic mass, and they are physically and chemically stable. Prototype modules have survived over 600 melt/freeze cycles without degradation. Advanced concepts to further improve performance are described. These concepts include the selection of ternary eutectic alloys to provide a wider range of useful melting temperatures and the use of infiltration to control the location of liquid alloy and to compensate for differences in thermal expansion. Author

**N91-17446#** Sandia National Labs., Albuquerque, NM.
**ANALYSIS AND DESIGN OF TWO STRETCHED-MEMBRANE PARABOLIC DISH CONCENTRATORS**
Thomas R. Mancini 1991 21 p Presented at the International Solar Energy Conference, Reno, NV
(Contract DE-AC04-76DP-00789)
(DE90-015831; SAND-90-2008C; CONF-910001-1) Avail: NTIS HC/MF A03

In this paper, the designs of the two Stretched-Membrane (SM) dishes are analyzed using the computer code CIRCE to model the optical performance of the concentrators and a thermal model, which includes conduction, convection, and radiation heat transfer, to calculate the thermal losses from the cavity solar receivers. The solar collector efficiency, defined as the product of the optical efficiency of the collector and the thermal efficiency of the receiver, is optimized for comparing the performance of several facet arrangements for the faceted SM dish and the single-element SM dish with the state-of-the-art glass-metal dish. Last, the initial designs of these two SM dishes are described along with the results of preliminary performance measurements on their respective optical elements. DOE

**N91-17447#** Sandia National Labs., Albuquerque, NM.
**PHOTOVOLTAIC CONCENTRATOR MODULE RELIABILITY: FAILURE MODES AND QUALIFICATION**
Elizabeth H. Richards 1990 6 p Presented at the 1990 Photovoltaic Module Reliability Workshop, Denver, CO, 25 Oct. 1990
(Contract DE-AC04-76DP-00789)
(DE91-004290; SAND-90-2966C; CONF-9010260-1) Avail: NTIS HC/MF A02

The purpose of this paper is to discuss the current issues of interest in PV concentrator module reliability. Before describing in detail the reliability concerns about PV concentrator modules, it should be emphasized that, with proper design and attention to quality control, there is nothing to prevent concentrator modules from being as reliable as crystalline-silicon flat-plate modules have proven to be. Concentrator modules tested outdoors, as well as in the first-generation systems, have generally been reliable, and no degradation in cell output has been observed. Also, although they are not included in this paper, there are a few items currently of concern to the reliability of other PV module technologies that are not issues with PV concentrator technology, such as the stability of amorphous-silicon efficiencies and concerns about EVA encapsulation. DOE

**N91-17448#** Sandia National Labs., Albuquerque, NM. Dept. of Fluid and Thermal Sciences.
**NUMERICAL MODELING OF DISH-STIRLING REFLUX SOLAR RECEIVERS**
R. E. Hogan 1990 21 p Presented at the 13th ASME-JSME International Solar Energy Conference, Reno, NV, 17-22 Mar. 1991
(Contract DE-AC04-76DP-00789)
(DE91-004510; SAND-89-1628C; CONF-910318-5) Avail: NTIS HC/MF A03

Using reflux solar receivers to collect solar energy for dish-Stirling electric power generation systems is currently being investigated by several organizations, including Sandia National Laboratories, Albuquerque, New Mexico. In support of this program, Sandia has developed two numerical models describing the energy transfer within and thermal performance of pool-boiler and heat-pipe receivers. Both models are applicable to axisymmetric geometries and they both consider the radiative and convective energy transfer within the receiver cavity, the conductive and convective energy transfer within the receiver cavity, the conductive and convective energy transfer from the receiver housing, and the energy transfer to the receiver working fluid. In these models, the radiative transfer within the receiver is analyzed using a two-band (solar and infrared) net-radiation formulation for enclosure radiation. Empirical convective correlations describe the convective heat transfer from the cavity to the surroundings. The primary difference between the models is the level of detail in modeling the heat conduction through the receiver walls. The more detailed model uses a two-dimensional finite control volume method, whereas the simpler model uses a one-dimensional thermal resistance approach. DOE

**N91-17449#** Sandia National Labs., Albuquerque, NM. Wind Energy Div.
**A 34-METER VAWT (VERTICAL AXIS WIND TURBINE) POINT DESIGN**
T. D. Ashwill, D. E. Berg, H. M. Dodd, M. A. Rumsey, H. J. Sutherland, and P. S. Veers 1991 8 p Presented at the 13th ASME-JSME International Solar Energy Conference, Reno, NV, 17-22 Mar. 1991
(Contract DE-AC04-76DP-00789)
(DE91-004565; SAND-90-2030C; CONF-910318-6) Avail: NTIS HC/MF A02

The Wind Energy Division at Sandia National Laboratories recently completed a point design based on the 34-m Vertical Axis Wind Turbine (VAWT) Test Bed. The 34-m Test Bed research machine incorporates several innovations that improve Darrieus technology, including increased energy production, over previous machines. The point design differs minimally from the Test Bed; but by removing research-related items, its estimated cost is substantially reduced. The point design is a first step towards a Test-Bed-based commercial machine that would be competitive with conventional sources of power in the mid-1990s. DOE

**N91-17450#** Sandia National Labs., Albuquerque, NM.
**AN UPDATE ON THE DEVELOPMENT OF HEAT-PIPE SOLAR RECEIVERS FOR STIRLING/DISH-ELECTRIC SYSTEMS**
D. R. Adkins and T. M. Godett (Stirling Thermal Motors, Inc., Ann Arbor, MI.) 1991 7 p Presented at the 13th ASME-JSME International Solar Energy Conference, Reno, NV, 17-22 Mar. 1991
(Contract DE-AC04-76DP-00789)
(DE91-004568; SAND-89-3042C; CONF-910318-7) Avail: NTIS HC/MF A02

DOE is sponsoring the development of a 75 kW (thermal) heat pipe solar receiver to drive a 25 kW (electric) Stirling engine/generator system. A heat pipe solar receiver transfers energy from the focus of a parabolic dish solar concentrator to the heater tubes of a Stirling engine through the evaporation and condensation of a liquid metal. With a heat pipe receiver, it is possible to transform irregular flux profiles from solar concentrators into a more uniform thermal input at the engine's heater tubes. Recent work in the heat pipe receiver development program is reviewed. Techniques for constructing the heat pipe receiver's wick structure are discussed and findings from recent bench-scale tests are presented. Several problem areas are addressed that were discovered in the course of this program. DOE

**N91-17451#** Colorado State Univ., Fort Collins. Solar Energy Applications Lab.
**COLORADO STATE UNIVERSITY PROGRAM FOR DEVELOPING, TESTING, EVALUATING, AND OPTIMIZING SOLAR HEATING AND COOLING SYSTEMS Project Status Report, 1 Nov. - 31 Dec. 1990**
Jan. 1991 21 p
(Contract DE-FG03-86SF-16306)
(DE91-005778; DOE/SF-16306/28) Avail: NTIS HC/MF A03

This report discusses the following tasks: (1) solar heating with isothermal collector operation and advanced control strategy; (2) solar cooling with solid desiccant; (3) liquid desiccant cooling system development; (4) solar house III -- development and improvement of solar heating systems employing boiling liquid collectors; (5) generic solar domestic water heating systems; (6) advanced residential solar domestic hot water (DHW) systems; (7) management and coordination of Colorado State/DOE program; and (8) the field monitoring workshop. DOE

**N91-17452*#** Lockheed Sanders, Inc., Nashua, NH.
**ADVANCED STIRLING RECEIVER DEVELOPMENT PROGRAM, PHASE 1 Final Report, Dec. 1988 - Jul. 1990**

Charles A. Lurio 18 Jul. 1990 119 p
(Contract NAS3-25471)
(NASA-CR-185281; NAS 1.26:185281) Avail: NTIS HC/MF A06 CSCL 10B

Critical technology experiments were designed and developed to evaluate the Stirling cavity heat pipe receiver for a space solar power system. Theoretical criteria were applied to the design of a module for containing energy storage phase change material while avoiding thermal ratcheting. Zero-g drop tower tests, without phase change, were conducted to affirm that the bubble location required to avoid ratcheting could be achieved without the use of container materials that are wetted by the phase change material. A full scale module was fabricated, but not tested. A fabrication method was successfully developed for the sodium evaporator dome, with a sintered screen wick, to be used as the focal point for the receiver. Crushing of the screen during hydroforming was substantially reduced over the results of other researchers by using wax impregnation. Superheating of the sodium in the wick under average flux conditions is expected to be under 10K. A 2000K furnace which will simulate solar flux conditions for testing the evaporator dome was successfully built and tested. Author

# 45 ENVIRONMENT POLLUTION

Includes atmospheric, noise, thermal, and water pollution.

**N91-17453** National Academy of Sciences - National Research Council, Washington, DC. Committee on Global Change.
**GLOBAL CHANGE AND OUR COMMON FUTURE. PAPERS FROM A FORUM**
Ruth S. DeFries, ed. and Thomas F. Malone, ed. (Saint Joseph's Coll., West Hartford, CT.) National Academy Press 1989 231 p Forum held in Washington, DC, 2-3 May 1989
(LC-89-62950; ISBN-0-309-04089-2) Copyright Avail: Issuing Activity

The objectives of this forum were threefold: (1) to present to the public a balanced and authoritative view of the wide range of global change issues, including the science of the earth system, the impacts of global change on society, and the implications for public policy; (2) to describe developments in the emerging interdisciplinary approach to the study of the earth system, aimed toward developing the knowledge base on which rational public policy decisions on global change can be pursued; and (3) to delineate the social, political, and economic framework within which the scientific and technological issues and the policy options need to be explored. The document is divided into the following topics (1) society's stake in global change; (2) the Earth system; (3) impacts of global change; and (4) implications for public policy. For individual title, see N91-17454.

**N91-17454*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
**GLOBAL CHANGE AND CARRYING CAPACITY: IMPLICATIONS FOR LIFE ON EARTH**
Paul R. Ehrlich, Gretchen C. Daily, Anne H. Ehrlich, Pamela Matson, and Peter Vitousek (Stanford Univ., CA.) *In* National Academy of Sciences - National Research Council, Global Change and Our Common Future. Papers from a Forum 1989 p 19-27 (For primary document see N91-17453 09-45)
Avail: Issuing Activity CSCL 13B

Determining the long-term number of people that the planet can support without irreversibly reducing its ability to support people in the future, i.e., the carrying capacity of the Earth, is an exceedingly complex problem. About all that is known for certain is that, with present and foreseeable technologies, the human population has already exceeded the capacity. The reduction in carrying capacity that can be expected to result from direct human impacts on resources and the environment and from our indirect impacts of the climate system is discussed. Global warming and modeling global change and food security are also discussed with respect to carrying capacity. Author

**N91-17455#** Lawrence Livermore National Lab., CA.
**GREENHOUSE GASES: CHANGING THE GLOBAL CLIMATE**
Michael C. MacCracken Apr. 1990 16 p Presented at the Workshop on Global Climate Change and Its Effects on California, Davis, CA, 10-12 Jul. 1989
(Contract W-7405-eng-48)
(DE90-011459; UCRL-101837-REV-1; CONF-8907191-2-REV-1)
Avail: NTIS HC/MF A03

The increasing atmospheric concentrations of carbon dioxide and other radiatively active gases will enhance the ability of the atmosphere to trap infrared radiation and thereby lead to warming of Earth's climate. Numerical models suggest that the global average surface air temperature can be expected to increase a few degrees during the twenty-first century. This estimate is probably uncertain by a factor of at least two. The uncertainties in estimates of regional changes of temperature and precipitation are even greater. Despite these uncertainties, however, there is broad agreement that the persistence and rapidity of such changes would be unprecedented in historical times. To moderate the projected climatic and environmental changes, the rate of emissions of greenhouse gases must be slowed while alternative energy technologies are developed. DOE

**N91-17456#** National Academy of Sciences - National Research Council, Washington, DC. Committee on Alternative Energy Research and Development Strategies.
**CONFRONTING CLIMATE CHANGE: STRATEGIES FOR ENERGY RESEARCH AND DEVELOPMENT**
1990 142 p
(Contract DE-AC01-89EH-89027)
(ISBN-0-309-04347-6; LC-90-62882) Avail: NTIS HC/MF A07

Five expert panels were constituted by the National Research Council to support the Committee on Alternative Energy Research and Development Strategies. In the context of the committee's charge directed at reducing emissions of greenhouse gases in energy production and use in the U.S., the panels addressed opportunities in the electric power, transportation, buildings, and industry market sectors and strategies for energy R and D and technology adoption. The document is divided into the following topics: (1) strategies for reducing greenhouse gas emissions; (2) background; (3) a framework for planning and implementing energy research and development; and (4) potential for reducing emissions of greenhouse gases. Author

**N91-17457#** National Academy of Sciences - National Research Council, Washington, DC.
**THE US GLOBAL CHANGE RESEARCH PROGRAM: AN ASSESSMENT OF THE FY 1991 PLANS**
1990 122 p
(Grant NSF OCE-90-14447)
(LC-90-62105; ISBN-0-309-04328-X) Avail: NTIS HC/MF A06

This report was prepared in response to a request that the National Research Council (NRC) assess whether the FY 1991 plan for the U.S. Global Change Research Program (USGCRP) is a sound approach to reducing the scientific uncertainties regarding global change issues. The charge included several specific questions concerning the plans for the Earth Observing System (a large, single initiative of NASA) in the context of the USGCRP. The report was prepared by two coordinated panels established under the auspices of the NRC Committee on Global Change. Author

**N91-17458#** North Carolina Univ., Chapel Hill. Dept. of Environmental Sciences and Engineering.
**TESTING OF A MODEL TO ESTIMATE VAPOR CONCENTRATION OF VARIOUS ORGANIC CHEMICALS M.S. Thesis**
Stephen M. Bakalyar 1990 167 p Sponsored by AFIT, Wright-Patterson AFB, OH
(AD-A224956; AFIT/CI/CIA-90-058) Avail: NTIS HC/MF A08 CSCL 13/2

A model developed by Dr. Parker C. Reist to predict the build-up and decay rates of vapor concentrations following a chemical spill

and clean-up was tested. The chemicals tested were: acetone, butyl acetate, ethyl acetate, hexane, methylene chloride, methyl ethyl ketone, and toluene. The evaporation rates of these chemicals were determined both by prediction, using a model developed by I. Kawamura and D. Mackay, and empirically and these rates were used in the Reist model. Chamber experiments were done to measure actual building-up and decay of vapor concentrations for simulated spills and simulated clean-up. GRA

**N91-17459#** Council on Environmental Quality, Washington, DC.
**NATIONAL ACID PRECIPITATION ASSESSMENT PROGRAM TO THE PRESIDENT AND CONGRESS Annual Report, 1989**
Jun. 1990 105 p
(PB90-237330) Avail: NTIS HC/MF A06 CSCL 13B

The program's research and assessment accomplishments during 1989 are described. The findings update section summarizes recent developments in the state of scientific knowledge of the causes and effects of acidic deposition, and provides information on the status and capabilities of various acid deposition control technologies. The National Acid Precipitation Assessment Program (NAPAP) is developing a comprehensive integrated assessment of the causes and effects of acid deposition, combined with comprehensive analysis of the cost and effectiveness of various emission reduction strategies. GRA

**N91-17460#** Council on Environmental Quality, Washington, DC.
**NATIONAL ACID PRECIPITATION ASSESSMENT PROGRAM. ACIDIC DEPOSITION: AN INVENTORY OF NON-FEDERAL RESEARCH, MONITORING, AND ASSESSMENT INFORMATION**
Charles N. Herrick, ed. Jan. 1990 546 p
(PB90-237579) Avail: NTIS HC/MF A23 CSCL 13B

The Acid Precipitation Act of 1990 established the Interagency Task Force on Acid Precipitation to develop and implement the National Acid Precipitation Assessment Program (NAPAP). The presented information was provided to NAPAP's Task Group Leaders and State-of-Science and State-of-Technology authors in July 1989. The early release was intended to assure that the authors would be aware of the information at an early phase in the assessment production process. GRA

**N91-17461#** Council on Environmental Quality, Washington, DC.
**NATIONAL ACID PRECIPITATION ASSESSMENT PROGRAM: ASSESSMENT HIGHLIGHTS**
5 Sep. 1990 32 p
(PB90-237587) Avail: NTIS HC/MF A03 CSCL 13B

The document consists of the draft highlights of the National Acid Precipitation Assessment Program (NAPAP) Integrated Assessment. The study is intended to provide information on: (1) specific regions where the environment is affected by acidity and the extent to which acidic deposition and other air pollutants contribute to those adverse effects; (2) how and where emissions are transformed into acids and how they are distributed; (3) whether the effects are extensive and require mitigation; and (4) what emission control technologies, strategies, and mitigation options are available to reduce acidic deposition and related air pollution. The document may be revised on the basis of comments received during the public review period and as a result of completion of the peer and agency review processes, consistent with NAPAP guidelines. GRA

**N91-17462#** Council on Environmental Quality, Washington, DC.
**NATIONAL ACID PRECIPITATION ASSESSMENT PROGRAM: MODELS PLANNED FOR USE IN THE NAPAP INTEGRATED ASSESSMENT**
Dec. 1989 181 p
(PB90-237645) Avail: NTIS HC/MF A09 CSCL 13B

The major focus of the National Acid Precipitation Assessment Program (NAPAP), as well as related programs conducted by non-federal organizations, was the development of numerical models to enhance understanding of the acidification process and its effects. The purpose of the report is to provide basic information about the the models planned for use in the integrated assessment. The models described are listed, and particular attention is focused on the status of model evaluation in order to provide information on the suitability of a model for its use in the integrated assessment. The document enables an overview of all relevant NAPAP models to be provided in a single report, but does not describe each model in detail. GRA

**N91-17463#** National Weather Service, Melbourne, FL.
**THREE INITIAL CLIMATOLOGICAL STUDIES FOR MELBOURNE, FLORIDA: A FIRST STEP IN THE PREPARATION FOR FUTURE OPERATIONS**
Gary K. Schmocker, David W. Sharp, and Bartlett C. Hagemeyer Oct. 1990 58 p Sponsored by National Weather Service, Fort Worth, TX
(PB91-100222; NOAA-TM-NWS-SR-132) Avail: NTIS HC/MF A04 CSCL 13B

A monthly climatology of temperature and precipitation for central Florida and a daily temperature climatology for Melbourne, Florida, were produced to aid in the preparation of routine forecasts at the new National Weather Service (NWS) Office in Melbourne. A detailed tornado climatology for the land area within 125 nm of Melbourne was also produced to assess risk and identify suitable forecast problems relating to severe weather for investigation. The information is part of a large body of meteorological knowledge forecasters will need for their new forecast and warning areas as the NWS undergoes a far reaching Modernization and Associated Restructuring (MAR) in the 1990s. The procedures and results presented are useful for forecasters in central Florida and instructive for other weather service offices. GRA

**N91-17464#** State Univ. of New York, Albany.
**ASSESSMENT OF ATMOSPHERIC EXPOSURE AND DEPOSITION TO HIGH ELEVATION FORESTS IN THE EASTERN UNITED STATES**
V. A. Mohnen, V. Aneja, B. Bailey, E. Cowling, and S. M. Goltz Sep. 1990 219 p Prepared in cooperation with North Carolina State Univ., Raleigh; Associated Weather Services, Albany, NY; and Maine Univ., Orono Sponsored by EPA
(PB91-100164; EPA/600/3-90/058) Avail: NTIS HC/MF A10 CSCL 13B

The results are summarized of the four year field measurement and data analysis program of Mountain Cloud Chemistry Program (MCCP). The objectives of the project were met and the result is an assessment of principal atmospheric constituents as they impact the high elevation forests of the Eastern U.S. Deposition of SO4(-2), NO3(-), H(+), and NH(4+) in cloud water represents a significant input to forest canopies with elevations greater than 1000 m. Cloud water deposition can exceed wet (rain) deposition and may be the dominant process for input of sulfate and nitrate compounds during the growing season in high elevation forests frequently exposed to clouds. Cloud water pH concentrations may be as much as 0.6pH units lower than pH in rain. SO(4+) and NO3(-) concentrations are also higher in cloud water than in precipitation. Ozone data reveals that large differences exist between ozone concentrations at high elevation and low elevation sites. The primary effect of the difference is to produce higher mean ozone concentrations and longer episodes at the higher elevation sites. Author

**N91-17465#** Environmental Science and Engineering, Inc., Gainesville, FL.
**ONTARIO MINISTRY OF THE ENVIRONMENT: AIR QUALITY IN ONTARIO, 1988 Annual Report**
1990 120 p
(PB91-100305) Avail: NTIS HC/MF A06 CSCL 13B

The 1988 Ontario air quality monitoring program is described, including a summary of the measurements of gases and particulate matter during the year. A discussion of the characteristics, effects, Ontario criteria (if any), sources, method of monitoring, locations (and frequency) of sampling, summary of sampling results, and

the one year trend are given. The location of stations and the sample distribution information, which includes means, maxima, and the number of exceedances of the Ontario criteria are also included, along with a summary of the entire continuous (hourly) network which gives station name, numerical identifier, and an indication of the continuous pollutants measured (suspended particles, sulfur dioxide, carbon monoxide, ozone, nitrogen, nitrogen dioxide, nitric oxide, oxides of nitrogen, total hydrocarbons, reactive hydrocarbons, and total reduced sulfur). GRA

**N91-17466#** NSI Technology Services Corp., Corvallis, OR.
**ATLAS OF AIR QUALITY AND DEPOSITION IN OR NEAR FORESTS OF THE WESTERN UNITED STATES**
M. Boehm and T. Vandetta Sep. 1990 465 p Prepared in cooperation with Oregon State Univ., Corvallis Sponsored by Corvallis Environmental Research Lab.
(Contract EPA-66-C8-0006)
(PB91-106229; EPA/600/3-90/081) Avail: NTIS HC/MF A20 CSCL 13B

An atlas of air quality and deposition data was compiled to make air pollution data and information more accessible to biologists and ecologists working in western forests. Data from the 1985 National Acid Precipitation Assessment Program Emission Inventory are used to characterize emissions of sulfur dioxide and nitrogen oxides across the West. Maps illustrating location, type, and magnitude of major point source emissions together with pie charts of the percent contribution by source category are presented alphabetically by state. Data from the Environmental Protection Agency databases AIRS and SAROAD are used to characterize ambient levels of sulfur dioxide and ozone for three averaging periods, viz., annual, May through October or growing season, and monthly. Data for 20 sulfur dioxide and 70 ozone sites in or near western forests are presented by state. Biographic information together with standard summary statistics are given for each site. GRA

**N91-17467** Colorado State Univ., Fort Collins.
**EDDY DIFFUSIVITIES FOR SENSIBLE HEAT, OZONE, AND MOMENTUM FROM EDDY CORRELATION AND GRADIENT MEASUREMENTS Ph.D. Thesis**
Karl Frederick Zeller 1990 157 p
Avail: Univ. Microfilms Order No. DA9029459

Micrometeorological field measurements of the fluxes and the gradients of momentum, sensible heat and ozone are presented and discussed. The eddy-correlation measurement techniques was used to obtain the flux data at the heights of three and eight meters. A method to accurately measure mass (ozone) gradients from surface-layer based meteorological towers was developed and used. Both flux and gradient measurements are used for the determination of eddy diffusivities. Exploratory analyses were made with the data to investigate similarity relationships between the eddy diffusivities of momentum K(sub m), sensible heat K(sub h), and mass K(sub c), where ozone was used as the mass tracer. Eddy-diffusivity ratios were computed using dimensionless-gradient ratios classified by atmospheric stability determined at the geometric mean of the measured heights. The assumption of similarity between the eddy diffusivities of ozone and sensible heat, K(sub c) = K(sub h), based on scalar turbulent transfer theory, was verified for unstable atmospheric conditions. The results for eddy diffusivities of sensible heat and ozone for stable atmospheric conditions however, show that diffusivities of sensible heat are 50 percent greater than diffusivities of ozone. Chemical reaction of ozone, and/or the need for flux-measurement corrections, decrease the resulting values for ozone diffusivities during the stable periods. The relationships between the eddy diffusivities of momentum and the eddy diffusivities of ozone, as well as those between momentum and sensible heat are controlled by free-convection conditions, K(sub m) is less than K(sub c) and K(sub m) is less than K(sub h). Theoretical flux measurement corrections were applied to a subset of the data in an attempt to investigate the concept of a constant flux layer and to validate flux correction theory. Dissert. Abstr.

**N91-17468#** Pechan (E. H.) and Associates, Inc., Springfield, VA.
**ANALYSIS OF AIR TOXICS EMISSIONS, EXPOSURES, CANCER RISKS, AND CONTROLLABILITY IN FIVE URBAN AREAS. VOLUME 2: CONTROLLABILITY ANALYSIS AND RESULTS**
Jim Wilson, Bob Coleman, Erica Laich, and Roger Powell (Environmental Protection Agency, Research Triangle Park, NC.) Apr. 1990 107 p
(PB90-259870; EPA/450/2-89/012B) Avail: NTIS HC/MF A06 CSCL 13B

The urban air toxics problem was studied to discern what combination of control measures can best be employed to mitigate the problem. Various control strategies were applied and the resulting reduction in aggregate cancer incidence that would occur between 1980 and 1995 was analyzed. Y.S.

**N91-17469#** National Oceanic and Atmospheric Administration, Research Triangle Park, NC. Atmospheric Research and Exposure Assessment Lab.
**ACROSS NORTH AMERICA TRACER EXPERIMENT (ANATEX): MODEL EVALUATION STUDY**
Terry L. Clark and R. D. Cohn Jun. 1990 160 p Prepared in cooperation with Analytical Sciences Corp., Durham, NC Sponsored by AF
(PB90-261454; EPA/600/3-90/051) Avail: NTIS HC/MF A08 CSCL 13B

Three perfluorocarbon tracer gases were released at 2.5- or 5.0-day intervals from two sites in central North America and sampled for 24-hr periods at 77 surface sites. The source-receptor distances ranged from less than 30 to 3000 km. The data were used to evaluate the long-range transport and diffusion simulations of acid deposition models and to establish a range of uncertainty for various model genres. The performances of three single-layer Lagrangian, six multiple-layer Lagrangian, and two multiple-layer Eulerian models were assessed using quantifiable measures based on the comparison of ensemble mean concentrations and plume width as well as trajectory errors expressed as a function of transport time. In general, the multiple-layer Lagrangian models performed best in simulating the transport of the tracers, while the Eulerian models performed best in simulating the ensemble concentration frequency distributions. After 0.5 day of transport, trajectory errors ranged from 100 to 400 km; after 2.5 days, the errors ranged from 300 to 800 km. Beyond 2.5 days, errors from four Lagrangian models plateaued, while errors for the other models continued to increase, peaking at nearly 1100 km after 3.5 days. Author

**N91-17470#** Environmental Protection Agency, Research Triangle Park, NC. Office of Air Quality Planning and Standards.
**USER'S MANUAL FOR OZIPM-4 (OZONE ISOPLETH PLOTTING WITH OPTICAL MECHANISMS), VOLUME 1 Final Report**
Jul. 1989 194 p
(PB90-261488; EPA/450/4-89/009A-VOL-1) Avail: NTIS HC/MF A09 CSCL 13B

Options in the OZIPM4 program and the development of the input file needed to run the program are presented. The OZIPM4 model is described including system structures, computer codes, input files, information needed to build the input file, and output options. Y.S.

**N91-17471#** Geo-Marine, Inc., Plano, TX.
**PROCEEDINGS OF A WORKSHOP ON NORTHERN GULF OF MEXICO ENVIRONMENTAL STUDIES PLANNING**
Robert S. Carney Jun. 1990 141 p Workshop held in New Orleans, LA, 15-17 Aug. 1989 Prepared in cooperation with Louisiana State Univ., Baton Rouge Sponsored in part by Minerals Management Service
(PB90-259805; OCS/MMS-90/0018) Avail: NTIS HC/MF A07 CSCL 13B

A meeting was held on August 15 to 17, 1989, in New Orleans to provide technical input into three planned minerals management

service (MMS) studies in the Gulf of Mexico. The studies were to be: (1) a process oriented ecosystem study in the Texas and Louisiana outer continental shelf (OCS) region (the TEXLA ecosystem study); (2) a long-term monitoring program designed to understand natural variation throughout the Gulf of Mexico OCS (the long-term monitoring study); and (3) a study to examine the potential of low-level, long-term chronic stresses at established oil and gas activities (effects of long-term production sites). MMS staff presented these projects from the management perspective. GRA

**N91-17472#** National Ocean Service, Anchorage, AK. Ocean Assessments Div.
**OUTER CONTINENTAL SHELF ENVIRONMENTAL ASSESSMENT PROGRAM. FINAL REPORTS OF PRINCIPAL INVESTIGATORS, VOLUME 67**
Jul. 1990 634 p
(PB90-260134; OCS/MMS-90/0044) Avail: NTIS HC/MF A99 CSCL 13B

The following subject areas are covered: distribution, abundance, and biology of blue king and Korean hair crabs around the Pribilof Islands; distribution, abundance, and diversity of the epifaunal benthic organisms in Alitak and Ugak bays, Kodiak Island, Alaska; distribution and abundance of some epibenthic invertebrates of the northeastern Gulf of Alaska with notes on the feeding biology of selected species; reproductive success in Dungeness crab (Cancer magister) during long-term esposures to oil-contaminated sediments; distribution and abundance of decapod larvae of the Kodiak shelf. Author

**N91-17473#** Environmental Protection Agency, Corvallis, OR.
**RESPONSE OF FOREST TREES TO SULFUR, NITROGEN, AND ASSOCIATED POLLUTANTS**
Kim G. Mattson, Lynn Y. Arnaut, Gregory A. Reams, Steven P. Cline, Charles E. Peterson, and Richard J. Vong (Oregon State Univ., Corvallis.) Sep. 1990 142 p
(PB90-270539; EPA/600/3-90/074) Avail: NTIS HC/MF A07 CSCL 13B

The National Acid Precipitation Assessment Program created the Forest Response Program (FRP) to assess the effects of acidic deposition on trees and forests in regions of the U.S. Research from the FRP and other programs is summarized in four Major Program Output documents that address policy questions regarding forest conditions, mechanisms of effects on air pollutants, and projected responses of pollutants on forests. Information is summarized up to February 1990. The major findings include several observations on mechanisms of effect. There is evidence that supports the hypothesis that acidic deposition alters soil chemical properties. Author

**N91-17474#** Colorado Univ., Boulder. Inst. of Arctic and Alpine Research.
**LANDSCAPE DYNAMICS IN THE ARCTIC FOOTHILLS: LANDSCAPE EVOLUTION AND VEGETATION SUCCESSION ON DISTURBANCES Progress Report, 1989-1990**
Donald A. Walker and Marilyn D. Walker 20 Oct. 1990 11 p
(Contract DE-FG02-84ER-60242)
(DE91-005348; DOE/ER-60242/T4) Avail: NTIS HC/MF A03

This document contains a summary of research accomplished by the University of Colorado's Institute of Arctic and Alpine Research (INSTAAR) Joint Facility for Regional Ecosystem Analysis (JFREA) for the Department of Energy's R and D research program for 1989 to 1990. Aerial photographs, orthophoto topographic maps, and digital elevation models (DEMs) of the Toolik Lake region site were prepared by Aeromap U.S. at 1:500 and 1:5000 scales. During August 1990, the region surrounding Toolik Lake was mapped at 1:5000 scale, and the intensive research grid was mapped at 1:500 scale. Mapped variables include vegetation, landforms, surface forms, and percentage surface water. Soil data from the Imnavait Creek and Toolik Lake sites are central to the analysis of landscape evolution. Soils were collected from the base of the O horizon at 72 gridpoints on the 1:500-scale map area at Imnavait Creek, and 85 grid points at Toolik Lake. Soils are being analyzed for percentage moisture, pH (saturated paste), electrical conductivity, percentage organic matter, nitrate, nitrogen, phosphorus, potassium, iron, manganese, copper. Soils were also collected from 81 permanent plots (199 horizons) which will be used for vegetation-environmental analyses. Permanent 1 (times) 1-meter point-quadrat plots were established at 85 points of the Toolik Lake grid. Data from the plots will be stratified according to slope position and terrain unit and used to compare vegetation structure and cover on different aged surfaces. Work continued on the study of the effects of road dust on tundra vegetation. DOE

**N91-17475#** Oak Ridge National Lab., TN. Environmental Sciences Div.
**ACID RAIN IN ASIA**
Robert S. Turner Dec. 1990 11 p Workshop held in Bangkok, Thailand, 19-23 Nov. 1990
(Contract DE-AC05-84OR-21400)
(DE91-005352; ORNL/FTR-3834) Avail: NTIS HC/MF A03

The traveler presented a paper entitled, Susceptibility of Asian Ecosystems to Soil-Mediated Acid Rain Damage, at the Second Workshop on Acid Rain in Asia. The workshop was organized by the Asian Institute of Technology (Bangkok, Thailand), Argonne National Laboratory (Argonne, Illinois), and Resource Management Associates (Madison, Wisconsin) and was sponsored by the U.S. Department of Energy, the United Nations Environment Program, the United Nations Economic and Social Commission for Asia and the Pacific, and the World Bank. Papers presented on the first day discussed how the experience gained with acid rain in North America and Europe might be applied to the Asian situation. Papers describing energy use projections, sulfur emissions, and effects of acid rain in several Asian countries were presented on the second day. The remaining time was allotted to discussion, planning, and writing plans for a future research program. DOE

**N91-17476#** Oak Ridge National Lab., TN. Energy Div.
**HUMAN DIMENSIONS OF GLOBAL ENVIRONMENTAL CHANGE OF THE INTERNATIONAL SOCIAL SCIENCE COUNCIL**
Stephen F. Rayner 18 Dec. 1990 8 p Symposium held in Palma, Spain, 25-27 Nov. 1990
(Contract DE-AC05-84OR-21400)
(DE91-005503; ORNL/FTR-3841) Avail: NTIS HC/MF A02

The traveler attended the meeting of the Standing Committee on the Human Dimensions of Global Environmental Change of the International Social Science Council (ISSC) and the Scientific Symposium organized by the Standing Committee. The purpose of the meeting and symposium was to discuss the draft framework and the workplan of the Standing Committee prior to its presentation to the 1990 Congress of the ISSC on November 28 to 30, 1990. The meetings indicate that ORNL Global Environmental Studies Center is on the international leading edge of human dimensions research, except in the area of human dimensions data systems. This weakness could be rectified by close collaboration with the efforts of the Consortium for International Earth Science Information Network (CIESIN) in Michigan. DOE

**N91-17477#** Central Research Inst. of Electric Power Industry, Tokyo (Japan). Energy and Environment Lab.
**DEVELOPMENT OF AN ATMOSPHERIC DIFFUSION EVALUATION METHOD INCORPORATING THERMAL AND TOPOGRAPHICAL EFFECTS. 4: TURBULENCE INTENSITY ESTIMATION METHODS USING OBSERVATION RESULTS**
K. Sada and Y. Ichikawa Apr. 1990 32 p In JAPANESE; ENGLISH summary
(DE91-736742; CRIE-T-89039) Avail: NTIS HC/MF A03

Since the k-epsilon model is based on the eddy viscosity concept, it is necessary to incorporate anisotropic effects in the model for atmospheric diffusion calculations. The k-epsilon model was used to calculate the wind velocity and the kinetic energy of turbulent motion on a flat plate, then proposed methods were applied to divide turbulent kinetic energy into directional turbulence intensities. Effective utilization of field observation results were

taken into consideration in some of the proposal methods. Calculated turbulence intensities and concentrations using a Markov-chain model were compared with those obtained from the wind tunnel experiments a CRIEPT's Komae Laboratory. It was concluded that the methods based on vertically observed turbulence intensities at stack position and algebraic representation of Reynolds stress provided good agreement not only with the turbulence intensities but also for the concentration profiles in the wind tunnel. The former is preferable because of its relative practicability. DOE

**N91-17478#** Environmental Protection Agency, Corvallis, OR.
**EFFECTS OF UV-B AND GLOBAL CLIMATE CHANGE ON RICE RESEARCH PLAN**
D. Olszyk, D. Tingey, S. Holman, D. Bachelet, P. Barnes, D. Brown, and K. Ingram (International Rice Research Inst., Manila, Philippines) Oct. 1990 65 p
(PB91-109983; EPA/600/3-90/087) Avail: NTIS HC/MF A04 CSCL 13B

Little is currently known about the response of rice plants to UV-B radiation, enriched CO2, or elevated temperature. Even less is known about the responses of important rice ecosystem components (pests, pathogens, weeds, nitrogen fixation, methanogensis) to these factors. To accurately determine the qualitative and quantitative nature of these effects will require a number of highly integrated experimental and modeling efforts, rigorous data quality control, and effective coordination of research activities between cooperating groups. To facilitate integration of research activities, the program takes a modified cascading approach with each task building upon the results of other tasks. The research tasks for the program fall into three groups: climate scoping, experimental, and assessment. GRA

**N91-17479#** Health Effects Research Lab., Research Triangle Park, NC.
**OZONE DOSIMETRY PREDICTIONS FOR HUMANS AND RATS**
John H. Overton, Richard C. Graham, Thomas R. McCurdy, and Harvey M. Richmond (Office of Air Quality Planning and Standards, Research Triangle Park, NC.) Nov. 1990 40 p
(PB91-113852; EPA/600/1-90/009) Avail: NTIS HC/MF A03 CSCL 13B

Ozone (O3) dosimetry model predictions are presented for rats and humans under several different scenarios as a part of a chronic lung injury risk assessment project for O3. These scenarios are based on the most recent empirical data and theoretical considerations in the field of O3 dosimetry. In addition to presenting the simulation results, the O3 dosimetry model used to make the predictions is discussed and the choice or method of selecting important physiological parameters explained. This includes anatomical dimensions, choices of rat and human ventilatory parameters, and the method of estimating human and rat upper respiratory tract uptake. Also a comparison of simulation results to recent experimental dosimetry results is discussed. Y.S.

**N91-17480#** Pacific Northwest Lab., Richland, WA.
**IMBEDDING DYNAMIC RESPONSES WITH IMPERFECT INFORMATION INTO STATIC PORTRAITS OF THE REGIONAL IMPACT OF CLIMATE CHANGE**
G. W. Yohe (Wesleyan Univ., Middletown, CT.) Nov. 1990 20 p Presented at the International Workshop on the Natural Resource and Economic Implications of Global Climate Change, Interlaken (Switzerland), 5-9 Nov. 1990
(Contract DE-AC06-76RL-01830)
(DE91-004744; PNL-SA-18767; CONF-9011150-1) Avail: NTIS HC/MF A03

It is becoming increasingly clear, at least on a theoretical level, that modelers of the potential impacts of climate change must impose that change upon the world as it will be configured sometime in the future rather than confine their attention to considerations of what would happen to the world as it looks now. Initial baselines which focus on current circumstances are certainly worthwhile points of departure in any study, of course, but the truth is that social, economic, and political systems will evolve as the future unfolds; and careful analysis of that evolution across a globe experiencing changes in its climate must be undertaken, as well. In the vernacular of the analysts' workroom, while it may be interesting to try to see what would happen to dumb farmers who continue to do things as they always have regardless of what happens, it is critically important to evaluate the need for any sort of policy response to climate change in a world of smart farmers who will have observed the ramifications of climate change and responded in their own best interest. DOE

**N91-17481#** Pacific Northwest Lab., Richland, WA.
**GLOBAL CLIMATE CHANGE POLICY ISSUES RELATED TO THE MOVEMENT OF INDUSTRY FROM DEVELOPED TO RAPIDLY INDUSTRIALIZING COUNTRIES**
A. M. Lesperance and L. A. Waltemath Oct. 1990 25 p Presented at the American Public Health Association Meeting, New York, NY, 30 Sep. - 4 Oct. 1990
(Contract DE-AC06-76RL-01830)
(DE91-005615; PNL-SA-17957; CONF-9009316-1) Avail: NTIS HC/MF A03

Global climate change policies adopted by developed countries may encourage industries to move to countries with less restrictive policies. The purpose of this study is to identify policy-driven issues that may result in such a movement. This report (1) summarizes the conclusions of previous studies that have explored the relationship between environmental regulations and industrial movement, (2) identifies and summarizes existing and proposed U.S. global climate change policy options, and (3) discusses issues and topics relating to possible industrial relocation because of the global climate change policy options. It concludes with recommendations for further research. Although Federal global climate change policy options are the primary focus of this report, some international and regional efforts addressing this issue are also included. A potential regional industrial migration issue is highlighted. DOE

**N91-17482#** Oak Ridge National Lab., TN.
**GREENHOUSE GAS EMISSIONS IN SUB-SAHARAN AFRICA**
Robin L. Graham, Robert D. Perlack, Anantha M. G. Prasad, Jack W. Ranney, and Daniel B. Waddle Nov. 1990 136 p
(Contract DE-AC05-84OR-21400)
(DE91-005629; ORNL-6640) Avail: NTIS HC/MF A07

Current and future carbon emissions from land-use change and energy consumption were analyzed for Sub-Saharan Africa. The energy sector analysis was based on UN energy data tapes while the land-use analysis was based on a spatially-explicit land-use model developed specifically for this project. The impacts of different energy and land-use strategies on future carbon emissions were considered. (A review of anthropogenic emissions of methane, nitrous oxides, and chlorofluorocarbons in Sub-Saharan Africa indicated that they were probably minor in both a global and a regional context. The study therefore was focused on emissions of carbon dioxide.) The land-use model predicts carbon emissions from land use change and the amount of carbon stored in vegetation (carbon inventory) on a yearly basis between 1985 and 2001. Emissions and inventory are modeled at 9000 regularly-spaced point locations in Sub-Saharan Africa using location-specific information on vegetation type, soils, climate and deforestation. Vegetation, soils, and climate information were derived from continental-scale maps while relative deforestation rates (percent of forest land lost each year) were developed from country-specific forest and deforestation statistics (FAO Tropical Forest Resources Assessment for Africa, 1980). The carbon emissions under different land use strategies in Sub-Saharan Africa were analyzed by modifying deforestation rates and altering the amount of carbon stored under different land uses. The considered strategies were: preservation of existing forests, implementation of agroforestry, and establishment of industrial tree plantations. DOE

**N91-17483#** Midwest Research Inst., Golden, CO.
**ANALYSIS OF APPLICATIONS OF SOLAR TECHNOLOGY FOR THE TREATMENT OF CHLORINATED ORGANIC WASTE**
Greg C. Glatzmaier Nov. 1990 5 p Presented at the 13th ASME-JSME International Solar Energy Conference, Reno, NV, 17-22 Mar. 1991
(Contract DE-AC02-83CH-10093)
(DE91-002121; SERI/TP-253-4017; CONF-910318-3) Avail: NTIS HC/MF A01

Recent work has demonstrated that concentrated solar energy can destroy many hazardous chemicals that are of national concern including, dioxins, polychlorinated biphenyls (PCBs), and chlorinated solvents. A detailed systems analysis was performed to determine the applicability of solar detoxification to the treatment of chlorinated solvents. This work determined the cost of destruction of trichlorethylene (TCE) a using conventional; a solar-based technology was compared for this application. This work provides a basis for choosing an application in which solar energy can be used to its fullest potential to solve a growing national problem.
DOE

**N91-17484#** Oregon Graduate Center for Study and Research, Beaverton.
**ATMOSPHERIC METHANE RESEARCH PROGRAM FOR A STUDY IN CHINA**
1991 25 p Sponsored in part by Biospherics Research Corp. and Andarz Co.
(Contract DE-FG06-85ER-60313; NSF ATM-84-14020; NSF DPP-82-07470; NSF DPP-87-17023)
(DE91-005573; DOE/ER-60313/5) Avail: NTIS HC/MF A03

The most significant results of recent research are that methane emissions from rice paddies are strongly dependent on the soil temperature and that the fluxes of methane from the Chinese rice paddies are up to 10 times greater on average compared with fluxes from rice paddies in other parts of the world. In addition to the main findings, there are a number of other significant results: (1) the extension of a time series of concentrations of methane and other gases at Minqin; (2) the data now span sufficiently long times to estimate trends and seasonal variations and to include Minqin in our global flask sampling network; (3) further work on bio-gas pits was completed; and (4) methane was also measured in Beijing and found relatively low concentrations for an urban area.
Author

# 46 GEOPHYSICS

Includes aeronomy; upper and lower atmosphere studies; ionospheric and magnetospheric physics; and geomagnetism.

For space radiation see *93 Space Radiation.*

**N91-17485#** National Oceanic and Atmospheric Administration, Washington, DC.
**BASELINE UPPER AIR NETWORK (BUAN) Final Report**
Oct. 1990 65 p
(NOAA-TR-NESDIS-52) Avail: NTIS HC/MF A04

The special data collection, processing, and evaluation done as a part of the Baseline Upper Air Network (BUAN) experiment are described. The processing and distribution of NOAA-10 overpass information, the collection of BUAN radiosonde observations, and their collocation with satellite data are also described. The principles and components of the TIROS Operational Vertical Sounder operational system used to test the BUAN hypothesis, and evaluation results are presented. The BUAN Hypothesis is analyzed with respect to field experiment and the evaluation results. The final archive of collocated BUAN radiosonde and satellite observations compiled by NOAA are described.
Y.S.

**N91-17486** Wisconsin Univ., Madison.
**THE BALANCE OF DYNAMIC VORTICITY FOR THE PRESIDENTS' DAY STORM Ph.D. Thesis**
Tom Harmon Zapotocny 1990 203 p
Avail: Univ. Microfilms Order No. DA9027535

The maintenance of isentropic dynamic vorticity, defined as the vertical component of the curl of momentum, is examined for the life cycle of the Presidents'Day storm. Dynamic vorticity and its tendency are also compared to the more commonly used kinematic vorticity and its tendency. Diagnostics are first performed on an inviscid numerical simulation of an amplifying baroclinic disturbance by a hybrid isentropic-sigma coordinate channel model. The main purpose for studying a simulation with the channel model is to examine the first-order balance of dynamic vorticity during development under simplified conditions. A more in-depth evaluation of dynamic vorticity is presented for an excellent numerical simulation of the Presidents' Day storm of 18 to 20 February 1979. Dynamic vorticity diagnostics for the Presidents' Day storm reveal the importance of mass asymmetries within an isentropic layer and also document the effect of weak static stability. Prior to cyclogenesis, a strong cyclonic circulation tendency exists from both the vertical advection of vorticity and tilting terms. Another important feature is the merging of two synoptic scale short waves; one propagating southeast from the Great Lakes states, the other moving northeast from the Gulf of Mexico. Cyclogenesis is initiated by the latter of these two short waves, while rapid development occurs when the Great Lakes short waves reaches the Middle Atlantic states. During rapid development, an assessment of the ageostrophic component on spin-up is obtained from a balance of the divergence term and pressure stresses. Spin-up from the ageostrophic component is largest ahead of the lower tropospheric warm front. The impact of an 80 m/s subtropical jet streak, which enhances upper tropospheric processes during development, is also examined.
Dissert. Abstr.

**N91-17487** New South Wales Univ., Kensington (Australia). School of Surveying.
**COMBINATION OF TERRESTRIAL AND GPS DATA FOR EARTH DEFORMATION STUDIES IN NEW ZEALAND Ph.D. Thesis**
Donald Bruce Grant 1988 3 p
Avail: Issuing Activity

Optimum procedures for detecting earth deformation from a combination of terrestrial and GPS geodetic observations are studied. The terrestrial, GPS, and deformation adjustment models are investigated. It is found that the parameters of vertical homogeneous strain are not well determined and that their estimation leads to difficulty in the interpretation of other deformation parameters. It is demonstrated that a 2D adjustment of triangular data is suitable for combination with GRS for the estimation of horizontal strain but that a 3D adjustment is required for best results when Earth Deformation Studies distances are included in the terrestrial data set.
Dissert. Abstr.

**N91-17488#** Cornell Univ., Ithaca, NY.
**[STUDY OF PLASMA WAVES AND WAVE PARTICLE INTERACTIONS IN SPACE] Final Report, Oct. 1980 - Sep. 1989**
Paul M. Kinter and Michael C. Kelley 21 Sep. 1990 19 p
(Contract N00014-81-K-0018; AF Proj. 4149)
(AD-A227539) Avail: NTIS HC/MF A03 CSCL 04/1

The search in this contract was directed toward the study of plasma waves and wave particle interactions in space. Using the Viking space craft, weak double layers were discovered and plasma irregularities were shown to be a universal phenomena in the magnetosphere. Using sounding rockets hydrogen Bernstein waves and electrostatic oxygen cyclotron waves were shown to be responsible for transversely accelerating ion conics. In another area the effects of injecting ion beams and VLF waves on the ionosphere and magnetosphere.
GRA

**N91-17489** Pennsylvania State Univ., University Park.
**A NUMERICAL STUDY OF THE GENESIS OF EXTRATROPICAL CONVECTIVE MESOVORTICES Ph.D.**

**Thesis**
Shuyi Chen 1990 192 p
Avail: Univ. Microfilms Order No. DA9032258

The genesis of extratropical convective mesovortices and the large-scale environmental features that influence the vortex formation were investigated. A hypothesis is proposed: that mesovortices form in the stratiform rain regions of MCSs due to the reduced local Rossby radius in such regions. A conceptual model of the mesoscale convective cyclogenesis is introduced, which described the three stages of the mesovortex formation. A modified version of the PSU/NCAR three-dimensional hydrostatic mesoscale model is used to simulate mesovortex genesis in analytically generated pre-MCS (Mesoscale Convective System) large-scale environments. The model simultaneously incorporates parameterized convection and a grid-resolvable convection scheme containing the effects of hydrostatic water loading, condensation, freezing, and sublimation. A 12 h control simulation is performed with a specified pre-MCS environment that is characterized by a middle-tropospheric short wave, a low-level jet ahead of the short wave trough, a large area of conditionally unstable air, a deep layer of moisture, and small vertical wind shear. A mesovortex forms within a stratiform region behind a leading convective line. The evolution and structure of the mesovortex is very similar to observations of the mesovortices associated with MCSs over land at midlatitudes. The effects of large-scale features on the formation of mesovortices are investigated in seven numerical experiments with various initial conditions. Dissert. Abstr.

**N91-17490** Colorado State Univ., Fort Collins.
**NUMERICAL SIMULATION OF A MESOSCALE CONVECTIVE COMPLEX: MODEL DEVELOPMENT AND NUMERICAL RESULTS Ph.D. Thesis**
Craig J. Tremback 1990 263 p
Avail: Univ. Microfilms Order No. DA9029450

A mesoscale numerical model was developed and used to study the environment which supported the development of a mesoscale convective complex (MCC). The hydrostatic numerical model was combined with the CSU cloud/mesoscale model in 1983 to form the CSU Regional Atmospheric Modeling System (RAMS). Some of the aspects of RAMS developed were a hydrostatic time-split time differencing scheme, a soil model, a higher-order forward upstream advection scheme, improved versions of two convective parameterization schemes, and an isentropic data analysis package. The goal of the numerical simulations was to employ the numerical model to study an MCC with higher space and time resolution than is available through observational means. While there were many differences, the coarse resolution control run simulated an MCC whose meso-alpha-scale structure evolved similarly with the observed convective system to establish the credibility of the model. Higher resolution simulations, made to increase the spatial resolution, compared favorably with the coarse resolution simulations. These results were examined for the important forcing mechanisms of this MCC. Results from a simplified two-dimensional simulation verified many features of the solenoid's behavior. Two higher resolution sensitivity simulations were performed. The first, in which the convective parameterization was not used, and the second sensitivity experiment with resolved microphysical parameterizations activated. Dissert. Abstr.

**N91-17491** Pennsylvania State Univ., University Park.
**MODEL STUDIES OF THE THERMODYNAMIC STRUCTURE IN THE MARINE CONVECTIVE BOUNDARY LAYER Ph.D. Thesis**
Shouping Wang 1990 176 p
Avail: Univ. Microfilms Order No. DA9032390

Two parametric models are used to study the various physical processes that regulate the vertical structures both in the dry convective boundary layer and in the cloud-topped marine boundary layer. For the dry convective boundary layer, a mean-gradient model is developed using a convective mass flux representation of the turbulent fluxes. A top-hat model of thermals is used to represent the average characteristics of updrafts and downdrafts in the buoyantly driven circulation. The convective mass flux is related to the convective velocity scale. In this parameterization, the vertical gradients of conserved variables are controlled by internal mixing through vertical mass transports inside the convective boundary layer, bottom mixing due to the surface processes, top mixing due to the entrainment, and lateral mixing between updrafts and downdrafts. Decoupling leads to the formation of a stable layer at the cloud base to separate cloud and subcloud layers. Thus, an existing two-layer cloud-topped marine boundary layer model is used. The model is modified to include the parameterizations of drizzle and energetic coupling between the cloud layer and the subcloud layer, the updraft fractional area in the cloud amount parameterization, and a simple radiation calculation. It is found that decoupling decreases the mass flux at the cloud base, and thus, limits the moisture supply to the cloud layer. Furthermore, a weak mass flux can result in a stratified structure. Consequently, solid stratocumulus clouds may break up due to the decoupling. Downstream and diurnal simulations indicate that drizzle and solar warming are important in determining the fractional cloudiness. Dissert. Abstr.

**N91-17492** Pennsylvania State Univ., University Park.
**THE GENESIS OF BOW ECHOES: A REAR INFLOW-INDUCED MESOCONVECTIVE STRUCTURE Ph.D. Thesis**
Morris Larry Weisman 1990 163 p
Avail: Univ. Microfilms Order No. DA9032391

Through a series of idealized simulations using a nonhydrostatic cloud model, the genesis of bow echoes was investigated: a long-lived bow-shaped systems of convective cells that is especially noted for producing long swaths of damaging surface winds. It is demonstrated that these bow echoes are produced only for a restricted range of environmental conditions, including a convective available potential energy of at least 2000/sq m/sq s and vertical wind shears of at least 20/ms over the lowest 2.5 to 5 km AGL. The key structural features include a 40 to 100 km long bow-shaped segment of convective cells, with a strong, rear-inflow jet penetrating to the leading edge of the bow at 2 to 3 km AGL and cyclonic and anticyclonic eddies on the north and south end of the bowed segment, respectively. This structure characteristically develops three to four hours into the lifetime of a convective system and may remain coherent for several hours. The evolution to th quasi-steady structure of the bow echo occurs systematically as the convectively produced cold pool strengthens over time, eventually producing a circulation that overwhelms the ambient shear. This forces the convective cells to advect rearwards above the cold air and weaken. The horizontal buoyancy gradient along the back edge of these rearward-advecting cells subsequently generate an elevated rear-inflow jet that penetrates to near the leading edge of the cold pool. The circulation of this jet helps negate the circulation of the cold pool, re-establishing deep, forced lifting at the leading edge of the system. For weaker-shear environments, the rear-inflow jet descends and spreads along the surface, with the circulation of the jet enhancing the circulation of the cold pool. Thus, the system continues to spread upshear and weaken. Dissert. Abstr.

**N91-17493** Pennsylvania State Univ., University Park.
**EQUATORIALLY TRAPPED WAVES IN VARYING BASIC STATES: STRUCTURES AND LATERAL FORCING PROCESSES Ph.D. Thesis**
Chi-Dong Zhang 1989 200 p
Avail: Univ. Microfilms Order No. DA9018302

Linear shallow water equations on an equatorial beta-plane are used to theoretically investigate the effects of atmospheric basic state on equatorial waves. With different varying basic states, three main topics are addressed: eigenfrequencies and meridional structures of free equatorial waves; mechanism of equatorial Rossby wave trapping; and equatorial wave responses to transient extratropical forcings. The free Rossby wave is shown to be less trapped in the equatorial basic westerlies than easterlies. In contrast, the westward propagating gravity wave and the mixed Rossby-gravity wave are less trapped inequatorial esterlies than westerlies. Equatorial Rossby wave trapping is explained in terms of potential vorticity conservation. In a divergent system, the Rossby

wave is equatorially trapped because of the latitude decay of the restoring force of the Rossby wave oscillation. The restoring force is measured by the perturbation relative vorticity induced by the gradient of the ambient potential vorticity, which can be modified by the basic geopotential field geostrophically balanced with a nonzero basic zonal flow. For transient extratropical forcings with zonal wavenumbers two to five and time scales of one to ten days, the equatorial responses are dominated by those of Rossby waves and are always stronger in equatorial westerlies than easterlies. The n = 1 and n = 2 Rossby modes are shown to be the most sensitive to the sign of the equatorial basic zonal flow. Equatorial Rossby wave responses to extratropical forcings are also found to be sensitive to the directions of meridional branches of the local Hadley cells as well as to their locations relative to the equator. The major conclusion is that the effects of the atmospheric basic state on equatorial waves are non-negligible in understanding the dynamics of the tropics and global teleconnections. Dissert. Abstr.

**N91-17494#** California Univ., Los Angeles.
**STORM INDUCED CHANGES OF THE TOPSIDE IONOSPHERE AS DEDUCED FROM INCOHERENT SCATTER RADARS M.S. Thesis**
Kevin John Lunn 1990 110 p Sponsored by AFIT, Wright-Patterson AFB, OH
(AD-A227899; AFIT/CI/CIA-90-106) Avail: NTIS HC/MF A06 CSCL 04/1

Incoherent scatter radar observations from Millstone Hill, Saint Santin, and Arecibo are used to illustrate changes of the topside ionosphere during a geomagnetic storm. These observations consist of electron density, electron and ion temperatures, and ion velocity components parallel and perpendicular to the magnetic field. These parameters can further describe changes in ion composition, electric fields, and neutral winds. Attention is given to a specific storm during the Equinox Transition Study (ETS) of September 1984. In order to isolate the storm effects in the topside ionosphere, a comparison will be made between a disturbed and quiet day. A novel result from this study is the finding of correlated oscillations between parallel and perpendicular ion velocity components which are apparently storm induced. Previously, these oscillations have been observed primarily at night, but now it's noticed that during storm conditions there are prominent oscillations during the day. GRA

**N91-17495#** Florida Univ., Gainesville. Dept. of Physics.
**NON-CRITICAL SUPERSTRINGS FROM TWO DIMENSIONAL N = 1 SUPERGRAVITY**
Zongan Qiu 1990 10 p
(Contract DE-FG05-86ER-40272)
(DE91-005039; DOE/ER-40272/115; UFIFT-HEP-90-28) Avail: NTIS HC/MF A02

We describe a class of non-critical superstrings of d less than 1 arising from N = 1 superconformal field theories coupled to 2-D supergravity. One loop partition functions are found and shown to be modular invariant. Furthermore the one loop partition functions vanish as consequences of identities of the character formula. DOE

**N91-17496#** Florida Univ., Gainesville. Dept. of Physics.
**THE SUPERSYMMETRIC GENERALIZED MODIFIED KdV HIERARCHY AND ODD MINIMAL SUPERCONFORMAL FIELD THEORIES COUPLED TO 20 SUPERGRAVITY, PART 2**
M. A. Awada 1990 15 p
(Contract DE-FG05-86ER-40272)
(DE91-005041; DOE/ER-40272/116; UFIFT-HEP-90-29) Avail: NTIS HC/MF A03

We further study the universal equations of the supersymmetric modified KdV (MKdV) hierarchy in its generalized form. We show that these equations describe the dynamical quantum equations of the odd series of N = 1 minimal (p,q) superconformal field theory coupled to N = 1 supergravity, in particular, those unitary series with p = 2k + 3, and q = 2k = 1. The string susceptibility of these models is (gamma)(sub sstr.)(sup 0) = -2/2k + 1. We demonstrate explicitly the cases k = 2 and 3. DOE

**N91-17497#** Bureau of Mines, Amarillo, TX. Helium Field Operations.
**HELIUM RESOURCES OF THE UNITED STATES, 1989 Bienniel Report, 1988-1989**
Richard D. Miller and John E. Hamak 1990 22 p
(PB91-110817; BUMINES-IC-9267; LC-90-2411) Avail: NTIS HC/MF A03 CSCL 08G

The helium resources base of the United States was estimated by the Bureau of Mines to be 894.6 Bcf as of January 1, 1989. These resources are divided into four categories in decreasing degree of the assurance of their existence: (1) helium in storage and in proved natural gas reserves, 282.4 Bcf; (2) helium in probable natural gas resources, estimated at 237.7 Bcf; (3) helium in possible natural gas resources, estimated to be 263.2 Bcf; and (4) helium in speculative natural gas resources, 111.4 Bcf. These helium resources are further divided into depleting and nondepleting, with the helium in storage being in a separate classification. The depleting resources are those associated with natural gasfields that are, or will be, produced for the natural gas they contain. Almost all of the helium in potential (probable, possible, and speculative) natural gas resources is included in this classification. These depleting resources are estimated to contain 775 Bcf of the total helium resource base. GRA

**N91-17498** Deutsche Geodaetische Kommission, Munich (Germany, F.R.).
**SYNTHETIC MODELS FOR NUTATION OF A DEFORMABLE EARTH MODEL Ph.D. Thesis - Stuttgart Univ.**
Hans-Werner Mikolaiski 1989 153 p In GERMAN; ENGLISH summary
(SER-C-354; ISBN-3-7696-9402-3; ISSN-0065-5325;
ETN-91-98637) Copyright Avail: Deutsche Geodaetische Kommission, D-8000 Munich 22, Marstallplatz 8, Postfach 220 002, Fed. Republic of Germany

The short periodic changes in rotation of a deformable Earth model are investigated. An axial symmetric ground state is defined by solving Clairant's equation with the spherical mass density given by a modified preliminary reference earth model (PREM), calculated from seismic observations. A displacement field fulfills the linearized momentum equation on the domain, which is approximately ellipsoidal. The linearized momentum equation is reduced from the ellipsoid to the mean sphere of the Earth. The calculated displacement field describes both the time dependent deformation and variation of rotation of the Earth. Two types of rotation are defined, either depending on the global trajectory (Tisserand system) or the local rotation (vorticity). Both types of rotation are calculated and compared for the surface of the Earth, as well as the whole Earth. ESA

**N91-17499#** State Univ. of New York, Albany.
**MICROPHYSICAL STUDIES OF NOCTILUCENT CLOUDS Final Technical Report**
Bernard Vonnegut Oct. 1990 10 p
(Contract N00014-85-K-0705)
(AD-A229020) Avail: NTIS HC/MF A02 CSCL 04/2

The primary objectives of this investigation were to determine the habit of ice crystals formed at low atmospheric temperatures and pressures, and to investigate their nucleation kinetics, i.e., whether the nucleation process is stochastic as when ice is nucleated in the liquid phase, or whether it is deterministic. An additional objective was to investigate what influence, if any, the presence of foreign substances, vapors and particulate matter, might exert upon nucleation kinetics, growth rates, and crystal habit. For this purpose, an attempt to modify and adapt well known techniques devised for studies of ice crystals under tropospheric conditions for use under noctilucent cloud conditions was made. GRA

**N91-17500#** Air Force Geophysics Lab., Hanscom AFB, MA. Earth Sciences Div.
**PROCEEDINGS OF THE 9TH ANNUAL DARPA/AFGL SEISMIC RESEARCH SYMPOSIUM Interim Scientific Report**
James F. Lewkowicz, ed. and Jeanne M. McPhetres, ed. 6 Nov. 1990 258 p Symposium held in Nantucket, MA, 15-18 Jun. 1987
(AF Proj. 2309)
(AD-A229025; GL-TR-90-0300; GL-ERP-1069) Avail: NTIS HC/MF A12 CSCL 17/10

The following subject areas are covered: focusing and defocusing of teleseismic P waves by known 3-D structure beneath Pahute Mesa; spherical wave propagation in low porosity brittle rocks; propagation-corrected Lg spectra to estimate yields of Soviet explosions and isolation and enhancement of regional phases for earthquakes in the Eastern United States; wave propagation modeling and regional discriminants; seismic attenuation and yield estimates: new results using the Lg phase; high frequency seismic source functions for cavity decoupled underground nuclear explosions; the damage mechanics of rock under explosion induced loads; a knowledge based system for analyzing data from a network of NORESS type arrays; detection and location capability of hypothetical monitoring networks in the Soviet Union; wide band slowness estimation using a small aperture seismic array; spectral determination of regional and teleseismic Lg attenuation and source multiplicity in explosions; and frequency variable filters and surface-wave amplitude analysis. GRA

**N91-17501#** Dartmouth Coll., Hanover, NH. School of Engineering.
**THE MAGNETOPAUSE BOUNDARY LAYER Final Technical Report, 19 Feb. 1987 - 18 May 1990**
Bengt U. O. Sonnerup and W. Lotko 29 Jun. 1990 28 p
(Contract F19628-87-K-0026; AF Proj. 2311)
(AD-A229061; GL-TR-90-0175) Avail: NTIS HC/MF A03 CSCL 04/1

Theoretical models have been developed to describe the structure of, and dynamical processes in the magnetopause current layer and the adjoining low latitude boundary layer (LLBL), including coupling of the latter to the dayside auroral ionosphere. Also a pilot study has been performed to demonstrate how information about magnetopause and boundary layer structure can be extracted from in-situ measurements of magnetic fields and plasma velocities. (1) Simple two-dimensional dynamic models of the LLBL and other shear flows have been developed and used to study the decay of shear layers, and the breakup of driven unstable shear flows, such as the LLBL, into quasisteady vortex rows similar to those observed in the post-noon auroral-zone ionosphere, or into turbulence. A steady-state viscous LLBL model was also generated in which the magnetic field deformation caused by the currents is included in a self consistent manner. (2) A viscous-resistive model of magnetic field annihilation at the magnetopause has been developed which allows for plasma flow along the reconnection line. (3) The structure of resistive and resistive dispersive MHD intermediate shocks has been determined and their possible role as part of the magnetopause structure assessed. (4) Certain geometric and dynamic properties of the magnetopause/LLBL have been extracted from Active Magnetospheric Particle Tracer Explorer/IRM data with special emphasis on magnetic-field reconnection and flux transfer events. GRA

**N91-17502#** Michigan Univ., Ann Arbor. Space Physics Research Lab.
**COLLABORATIVE STUDIES OF POLAR CAP IONOSPHERIC DYNAMICS Final Report, 1 Sep. 1986 - 30 Sep. 1989**
Timothy L. Killeen and Rick J. Niciejewski Mar. 1990 30 p
(Contract F19628-86-K-0037; AF Proj. 2310)
(AD-A229153; GL-TR-90-0087) Avail: NTIS HC/MF A03 CSCL 04/1

This contract was awarded to continue data acquisition and analysis efforts using a set of optical instruments housed in a trailer on the pier at Thule Air Base in Greenland. The primary experimental program was to remotely measure neutral winds and temperatures at about 250 km altitude. Published results from these investigations are included in this report. In addition, the following secondary programs were initiated during the term of this contract: (1) the measurement of neutral winds at about 95 km altitude; (2) the measurement of neutral temperatures at mesopause altitudes; and (3) the acquisition of all sky images of airglow/auroral emissions. The station operated in an automatic data acquisition mode during the months September to April during the period covered by this contract. This document describes the instrumentation at the site and displays the results of the analysis performed on the data acquired by the instrumentation. GRA

**N91-17503#** Air Force Geophysics Lab., Hanscom AFB, MA. Earth Sciences Div.
**PROCEEDINGS OF THE 11TH ANNUAL DARPA/AFGL SEISMIC RESEARCH SYMPOSIUM Interim Report**
James F. Lewkowicz, ed. and Jeanne M. McPhetres, ed. 6 Nov. 1990 521 p Symposium held in San Antonio, TX, 2-4 May 1989
(AF Proj. 7600)
(AD-A229228; GL-TR-90-0301; GL-ERP-1070) Avail: NTIS HC/MF A22 CSCL 17/10

The following subjects are covered: near source observations of quarry explosions; small explosion discrimination and yield estimation; Rg as a depth discriminant for earthquakes and explosions: a case study in New England; a comparative study of high frequency seismic noise at selected sites in the USSR and USA; chemical explosions and the discrimination problem; application of simulated annealing to joint hypocenter determination; frequency dependence of Q(sub Lg) and Q in the continental crust; statistical approaches to testing for compliance with a threshold test ban treaty; broad-band studies of seismic sources at regional and teleseismic distances using advanced time series analysis methods; effects of depth of burial and tectonic release on regional and teleseismic explosion waveforms; finite difference simulations of seismic wave excitation at Soviet test sites with deterministic structures; stochastic geologic effects on near-field ground motions; the damage mechanics of porous rock; nonlinear attenuation mechanism in salt at moderate strain; compressional- and shear-wave polarizations at the Anza seismic array; and a generalized beamforming approach to real time network detection and phase association. GRA

# 47 METEOROLOGY AND CLIMATOLOGY

Includes weather forecasting and modification.

**N91-17504#** World Meteorological Organization, Geneva (Switzerland). World Climate Data Program.
**THE GLOBAL CLIMATE SYSTEM: CLIMATE SYSTEM MONITORING, JUNE 1986 TO NOVEMBER 1988**
Nov. 1988 73 p Original contains color illustrations
(CSM-R-84/86) Avail: NTIS MF A01; print copy available at WMO, Geneva, Switzerland

This report is based on current scientific understanding of the climate system and provides a basis for the monitoring of global change. Due to deficiencies in the global observing system, the diagnostic analyses of cause-effect relationships are preliminary for some regions and some climatic events or processes. It is hoped that the review will promote further research and better observing systems that would lead to improved models of the complex interactive processes occurring within the climate system. An extensive bibliography is provided at the end of the report for further reading. The topics covered include: (1) a moderate warm episode of the southern oscillation in 1986 to 1987 followed by a pronounced cold phase in 1988; (2) global mean temperatures rise despite some cold anomalies at higher latitudes; (3) major droughts plague food-producing areas; (4) near-normal rainfall finally returns to the Sahel in 1988; (5) dramatic failure of the Indian monsoon in 1987 but ample rains in 1988 while variable conditions occur in other monsoon areas; (6) increase in trace gases in the atmosphere continues; (7) stratospheric ozone

depletion; (8) atmospheric aerosol concentrations stabilize; (9) increased tropical storm activity in the Eastern Atlantic in 1988; (10) pronounced upper-atmosphere blocking during the autumn and winter of 1987 to 1988 in the Northern Hemisphere; (11) notable rising trend in the sea-surface temperatures of the northwest part of the subtropical Pacific Ocean; (12) rapid drop in Great Lakes water levels to near-normal values; (13) a decrease in global cloudiness in 1987 and 1988; (14) little change in global ice cover but reduced snow cover in 1988; (15) significant rise in global sea level; (16) increasing desertification in China; (17) new evidence relating the solar cycle to variations in the atmosphere; and (18) seasonal summaries. Author

**N91-17505** Maryland Univ., College Park.
**CLOUD-RADIATION-DYNAMICS INTERACTION Ph.D. Thesis**
Yu-Tai Hou 1990 214 p
Avail: Univ. Microfilms Order No. DA9030916

The main mechanisms of cloud-radiation-dynamics interaction were investigated through a series of model simulations. An interactive cloud scheme (INTC), a zonally asymmetric time-invariant cloud scheme (ASYC), a zonally symmetric time-invariant cloud scheme (SYMC), and a no cloud radiative forcing scheme (NOCF) were developed for the study. The INTC scheme shows results superior to the previous climatological cloud scheme. The ASYC scheme shows a good correspondence to INTC but with enhanced cloud effect over the oceans. The SYMC scheme largely alters and redistributes radiative energy over the land and the oceans. It is shown that clouds globally reduce more than 30 W/sq m of outgoing longwave flux and 40 W/sq m absorbed shortwave flux. The change of shortwave radiation due to clouds has strong impact on the surface energy balance over the land, inducing a negative feedback process involving convection, precipitation, and cloud-radiation. This mechanisms leads to a more than 75 W/sq m reduction in zonal-mean surface latent heat flux, and a corresponding 4 MM/Day reduction in precipitation at low-latitudes. Unlike the shortwave cloud effect which relies substantially on total cloudiness, the change of longwave radiation depends heavily on the cloud type and structure. Deep convective clouds are favorable to enhancing convection, especially over the oceans, where surface temperature is largely constrained. This process, however, will compete with the influence from the sea-surface latent energy exchange, which may greatly alter the zonal pattern of the feedback process. Dissert. Abstr.

**N91-17506#** National Environmental Satellite Service, Washington, DC.
**THE IMPACT OF NOAA SATELLITE SOUNDINGS ON THE NUMERICAL ANALYSIS AND FORECAST SYSTEM OF THE PEOPLE'S REPUBLIC OF CHINA. PART 1: FGGE DATA. PART 2: DECEMBER 1987 DATA**
Arnold Gruber, Wang Zonghao, Albert Thomasell, T. S. Chen, and Irwin Ruff Apr. 1990 133 p
(AD-A227463; NOAA-TR-NESDIS-51) Avail: NTIS HC/MF A07 CSCL 04/2

The impact of NOAA satellite sounding data on the numerical analysis and forecast system of the People's Republic of China was investigated. Four experiments were conducted. They are: (1) NOSAT; which uses conventional data only and provides benchmark statistics for the performance of the forecast model, (2) SAT; which includes satellite and conventional data (3) ALLSAT; which uses satellite data only, except for conventional surface data required to define the 1000 mb height reference level, and (4) DATGUESS; which uses the ALLSAT analysis as the first guess to which conventional data are then added. Seven areas deemed to have adequate conventional data for definition of truth. The impact of satellite data was then assessed by computing systematic errors, changes in S1 skill score and root mean square errors for 24 and 48 h forecasts of Sea Level Pressure (SLP) and 500 mb height. Overall, the Chinese model is found to underforecast the strength of features in the mean SLP fields, i.e., pressures are too low near high pressure systems and too high near low pressure systems. The same type of pattern is also seen in the mean 500 mb height forecast. In general, satellite data have been shown to reduce systematic error near where the data have been introduced in the vicinity of low pressure systems. A positive impact on root-mean-square errors of up to 11.5 percent was observed over land for SLP and 8 percent over ocean for 500 mb height for forecast period of 48 h. GRA

**N91-17507#** National Weather Service, Fort Worth, TX.
**DIAGNOSING THUNDERSTORM POTENTIAL USING AFOS**
Gregory R. Patrick Sep. 1990 57 p
(PB90-238841; NOAA-TM-NWS-SR-131) Avail: NTIS HC/MF A04 CSCL 04B

The following set of guidelines can be used as a guide for thunderstorm forecasting and will focus on the three necessary ingredients for thunderstorm development: (1) low level moisture; (2) instability; and (3) lifting mechanism. All three of these ingredients are important for convection. The presence of each on a given day can be used to subjectively analyze the potential for thunderstorms. The forecaster must look at the relative strengths of each of the three to come up with a potential. For example, a very strong lifting mechanism, such as a strong cold front or vigorous short wave, might help overcome a lack of rich, deep low level moisture. Or the presence of extreme instability will help negate the lack of a strong lifting mechanism. GRA

**N91-17508#** National Oceanic and Atmospheric Administration, Boulder, CO. Wave Propagation Lab.
**RASS DEMONSTRATION ON A NOAA NETWORK WIND PROFILER**
K. P. Moran, D. B. Wuertz, R. G. Strauch, N. L. Abshire, and D. C. Law Sep. 1990 28 p
(PB90-268319; NOAA-TM-ERL-WPL-184) Avail: NTIS HC/MF A03 CSCL 04B

The National Oceanic and Atmospheric Admin. (NOAA) is constructing a wind profiler network in the central U.S. to evaluate the utility of nearly continuous wind data and its effect on short term weather forecasting. These Ultra High Frequency (404.37 MHz) radars can also measure vertical profiles of virtual temperature in the lower troposphere by the Radio Acoustic Sounding System (RASS) technique. Vertical temperature data are obtained with the same spatial and temporal resolution that are used for wind profiling. A series of tests was conducted in April and May 1990 to obtain a preliminary evaluation of how well RASS would operate with the new wind profilers for the NOAA network. The network prototype radar, located at Platteville, Co. was used to collect RASS data. RASS data from two other profilers were available for comparison. Height coverage of the RASS data began at 500 m above the surface and extended to 3.5 to 5.2 km with the NOAA network profiler. Author

**N91-17509*#** Pennsylvania State Univ., University Park. Dept. of Meteorology.
**INTERPRETATION OF COMBINED WIND PROFILER AND AIRCRAFT-MEASURED TROPOSPHERIC WINDS AND CLEAR AIR TURBULENCE Final Report**
D. W. Thomson, William J. Syrett, and C. W. Fairall 8 Jan. 1991 157 p
(Grant NAG8-50)
(NASA-CR-187785; NAS 1.26:187785) Avail: NTIS HC/MF A08 CSCL 04B

In the first experiment, it was found that wind profilers are far better suited for the detailed examination of jet stream structure than are weather balloons. The combination of good vertical resolution with not previously obtained temporal resolution reveals structural details not seen before. Development of probability-derived shear values appears possible. A good correlation between pilot reports of turbulence and wind shear was found. In the second experiment, hourly measurements of wind speed and direction obtained using two wind profiling Doppler radars during two prolonged jet stream occurrences over western Pennsylvania were analyzed. In particular, the time-variant characteristics of derived shear profiles were examined. Profiler data dropouts were studied in an attempt to determine possible reasons for the apparently reduced performance of profiling radar

operating beneath a jet stream. Richardson number and wind shear statistics were examined along with pilot reports of turbulence in the vicinity of the profiler. B.G.

**N91-17510** Colorado State Univ., Fort Collins.
**QUANTIFYING ICE NUCLEATION BY SILVER IODIDE AEROSOLS Ph.D. Thesis**
Paul Judson DeMott 1990 281 p
Avail: Univ. Microfilms Order No. DA9029411

Laboratory studies of artificial ice nucleating aerosols used for weather modification by cloud seeding have generally been inadequate for describing their complex action in the varied temperature, pressure, humidity, and cloud conditions that can be encountered in the atmosphere. A quantitative framework is provided for predicting ice formation by aerosol particles based on experiments which specifically target currently accepted mechanisms by which ice can form. A physical system for reproducing realistic atmospheric cloud conditions, the Colorado State University dynamic (controlled expansion) cloud chamber, is described. Physical simulations of adiabatic cloud formation and growth are demonstrated. Methodologies were also formulated to use the cloud chamber and other available instrumentation to isolate the action of ice nucleating aerosols by accepted primary ice nucleation modes. These methods were applied to the study of two chemically different silver iodide (AgI)-type aerosols, generated in the exact form in which they were used for seeding natural clouds. An available one dimensional numerical cloud model with microphysical detail was adapted for the equivalent simulation of experiments performed in the cloud chamber. The model was utilized as a diagnostic tool to estimate water supersaturation in association with experiments and it was used for comparison of the predictions of new ice nucleus formulations with observations from generalized seeding simulations conducted in the cloud chamber. The general implications of these new results were tested by using the model to simulate a few common seeding situations in the atmosphere, and the transferability of results was evaluated by modeling two actual seeding experiments conducted in summertime cumuli. Dissert. Abstr.

**N91-17511** Pennsylvania State Univ., University Park.
**A NUMERICAL INVESTIGATION OF WINTERTIME EAST COAST CYCLOGENESIS Ph.D. Thesis**
William Michael Lapenta 1990 179 p
Avail: Univ. Microfilms Order No. DA9032322

A nested version of the Penn State/ NCAR mesoscale model with 35-km fine-mesh resolution is used to study wintertime cyclogenesis along the east coast of the United States. Evaluation of the numerical results indicates that the model successfully reproduced most principal synoptic and mesoscale features associated with this complex East Coast cyclogenesis case, including storm path and intensification, coastal front structure, cold-air damming, circulations induced by a polar jet streak, low-level jets, and precipitation. In particular, this study supports four functions: (1) it provides an in-depth numerical examination of a case of East Coast cyclogenesis in which entrance region jet streak dynamics provides the dominant upper level support; (2) it reveals the existence of two air streams fed by moist onshore flow from the marine boundary layer east of the coastal front; (3) it explores the origin, history, and significance of these moist airstreams to cyclogenesis; and (4) it demonstrates that both airstreams are well developed during the early phase of cyclogenesis. A series of numerical experiments is designed to explore the impact of several physical processes on the evolution and interaction between atmospheric phenomena of differing scales, each of which contributed to the development of the storm. In particular, the physical processes studied include: (1) the role of diabatic heating associated with convective and grid-scale precipitation; (2) modification of the marine planetary boundary layer by fluxes of heat and moisture over the Gulf Stream; and (3) the role of a thermally direct transverse circulation about the entrance region of a strong polar jet streak. The numerical experiments indicate that the intensity of heavy precipitation and latent heat release along the coastal front has the greatest impact upon the development of this storm, in terms of timing, phase speed , and intensity. Dissert. Abstr.

**N91-17512** Pennsylvania State Univ., University Park.
**ON THE DEVELOPMENT AND USE OF FOUR-DIMENSIONAL DATA ASSIMILATION IN LIMITED-AREA MESOSCALE MODELS USED FOR METEOROLOGICAL ANALYSIS Ph.D. Thesis**
David R. Stauffer 1990 240 p
Avail: Univ. Microfilms Order No. DA9032381

The application of dynamic relationships to the analysis problem for the atmosphere is extended to use a full-physics limited-area mesoscale model as the dynamic constraint. A four-dimensional data assimilation (FDDA) scheme based on Newtonian relaxation or nudging is developed and evaluated in a mesoscale model, which is used as a dynamic-analysis tool. Which assimilation strategies and meteorological fields (mass, wind or both) have the greatest positive impact on the 72-h numerical simulations (dynamic analyses) of two mid-latitude, real-data cases are determined. The basic FDDA methodology is tested in a 10-layer version of the model with a bulk-aerodynamic (single-layer) representation of the planetary boundary layer (PBL), and refined in a 15-layer version of the model by considering the effects of data assimilation within a multilayer PBL scheme. As designed, the model solution can be relaxed toward either gridded analyses (analysis nudging), or toward the actual observations (obs nudging). The data used for assimilation include standard 12-hourly rawinsonde data, and also 3-hourly mesoalpha-scale surface data which are applied within the model's multilayer PBL. Assimilation of 3-hourly surface wind and moisture data into the 15-layer FDDA system was most effective for improving the simulated precipitation fields because a significant portion of the vertically integrated moisture convergence often occurs in the PBL. Overall, the best dynamic analyses for the PBL, mass, wind, and precipitation fields were obtained by nudging toward analyses of rawinsonde wind, temperature and moisture (the latter uses a weaker nudging coefficient) above the model PBL and toward analyses of surface-layer wind and moisture within the model PBL.
Dissert. Abstr.

**N91-17513#** Air Force Geophysics Lab., Hanscom AFB, MA. Atmospheric Sciences Div.
**MODELING THE VARIATION OF CLOUD COVER WITH VIEW ANGLE USING SPACE SHUTTLE CLOUD IMAGERY Interim Scientific Report**
J. W. Snow 10 May 1990 53 p
(AF Proj. 6670)
(AD-A227895; GL-TR-90-0130; GL-ERP-1064) Avail: NTIS HC/MF A04 CSCL 04/2

This report documents the development of numerous elementary cloud cover models and evaluates the capability of each comparison with actual data. The data are measurements of apparent cloud cover as a function of view angle obtained from space shuttle cloud photographs. Using these data a physically realistic model for cumuliform cloud fields is obtained. The model permits the determination of actual cloud cover from a single measurement of apparent cloud cover at a known view angle, at least for the single-layer totally opaque clouds considered in this research. Additionally, the model is used to specify the probability of cloud-free viewing from space through such cloud fields. These probabilities are compared with similar ones obtained from other models of cloud-free line-of-sight commonly in use. GRA

**N91-17514#** Pennsylvania State Univ., University Park. Dept. of Meteorology.
**THE MEASUREMENT OF AIR-SEA FLUXES Final Report**
C. W. Fairall and George S. Young 9 Oct. 1990 82 p
(Contract N00014-85-K-0250)
(AD-A228511) Avail: NTIS HC/MF A05 CSCL 04/2

This project involves the investigation of an indirect method of inferring surface fluxes of momentum, sensible heat and latent heat over the ocean. The work includes participation in the Humidity

Exchange Over the Sea (HEXOS) program, a multinational project involving a series of field measurements and theoretical development. The air-sea fluxes are important physical processes which must be parameterized in climate, synoptic, mesoscale, and boundary layer and oceanic numerical models. Because of the increasing contribution of sea spray and whitecap-produced water droplets, it has been suggested that the humidity and heat exchange is strongly nonlinear in wind speed. Thus, it is believed that high wind speed conditions, though brief in duration, may contribute a disproportionate amount to the air-sea budgets. This has a profound influence on local boundary layer structure and intensification of storms by baroclinic instability. It is important to realize that we have almost no hard data on air-sea fluxes over the open ocean (perhaps 20 numerical modelers for each real data point) and that estimates of the fluxes based on mean meteorological data and drag coefficients are totally unverified for winds greater than 12 m/s. Preliminary evidence suggests that fluxes derived from the drag coefficient method can be in error by more than a factor of two under changing sea-state and wind conditions. GRA

**N91-17515#** National Weather Service, Wilmington, NC.
**HISTORICAL ACCOUNT OF TROPICAL CYCLONES THAT HAVE IMPACTED NORTH CAROLINA SINCE 1586**
James D. Stevenson Jul. 1990 75 p Sponsored by National Weather Service, Bohemia, NY
(PB90-259201; NOAA-TM-NWS-ER-83) Avail: NTIS HC/MF A04 CSCL 04B

A compilation is presented of the tropical cyclones for which historical information could be found that have struck North Carolina, had any effect on the state, or passed close enough offshore to have been a serious threat to the coastal area. The decision as to whether some early storms met these criteria was made rather subjectively, since information as to both path and effects was incomplete and highly variable. Where available, information on maximum (or near maximum) wind speed experienced in connection with the storm is given. Prior to about 1870, actual measurements were not made, so only descriptive statements as could be gleaned from news accounts are given. In the days of the U.S. Signal Corps, and even the Weather Bureau until 1940, the highest wind given to for a storm was usually the maximum velocity, which was an average over a 5-minute period. In recent years, the highest sustained wind used by the National Weather Service is an average over 1-minute period. The descriptions of the early storms may reflect their severity, but are also dependent on the amount of material which could be located. Obviously, there were many storms in the 17th-19th centuries of which no records could be found. Author

**N91-17516#** National Oceanographic Data Center, Washington, DC.
**MARINERS WEATHER LOG, VOLUME 34, NUMBER 3, SUMMER, 1990 Quarterly Report**
R. M. DeAngelis 1990 89 p
(PB90-268608) Avail: NTIS HC/MF A05; also available SOD HC $6.00 as 703-029-00000-1 CSCL 04B

The subject areas covered are: mystery at Caroline Island; castaway; watersprout watch; satcats; whale oil and wicks; radio officer tips; ocean queries; editor's desk; sea photography; marine observation program; and hurricane alley. Author

**N91-17517#** National Oceanic and Atmospheric Administration, Boulder, CO. Wave Propagation Lab.
**FRONTS, JET STREAMS, AND THE TROPOPAUSE**
M. A. Shapiro and D. Keyser Aug. 1990 79 p Sponsored by the State Univ. of New York at Albany
(PB90-268277; NOAA-TM-ERL-WPL-182) Avail: NTIS HC/MF A05 CSCL 04B

Past and present interpretations that have arisen regarding the structure and governing dynamics of fronts, jet streams, the tropopause, and the life cycle of the marine extratropical cyclone and its fronts is reviewed. It is shown that new insights and the resolution of previous controversies were linked, in part, to technological advances in atmospheric observing systems and, more recently, to the use of computers for diagnosis and numerical simulation. GRA

**N91-17518#** National Hurricane Center, Coral Gables, FL.
**DIAGNOSTIC REPORT OF THE NATIONAL HURRICANE CENTER, AUGUST AND SEPTEMBER, 1989, VOLUME 2, NUMBER 2**
Colin J. McAdie, ed. and Edward N. Rappaport, ed. 1989 156 p
(PB91-113225) Avail: NTIS HC/MF A08 CSCL 04B

An overview is presented of Tropical activity for August and September of 1989. Tropical cyclone activity in the Atlantic Basin and in the Eastern Pacific Basin is also presented. Author

**N91-17519#** Air Force Environmental Technical Applications Center, Scott AFB, IL.
**WET-BULB GLOBE TEMPERATURE: A GLOBAL CLIMATOLOGY**
Oct. 1990 23 p
(AD-A229028; USAFETAC/TN-90/005) Avail: NTIS HC/MF A03 CSCL 04/2

The wet-bulb globe temperature (WBGT) is considered the most practical heat stress index characterizing the effect of a heat stress environment on the individual. WBGT was developed because the dry-bulb temperature alone does not provide a realistic guide to the effects of heat, inasmuch as it does not take humidity and heat radiation into consideration. WBGT is so-called because two of its input variables are wet-bulb temperature and a black-globe temperature; the third variable is the shielded dry-bulb temperature. The wet-bulb temperature used in computing WBGT is taken from a stationary thermometer exposed to the sun and prevailing wind. WBGT climatology for three major areas of the globe (North and South America, Africa, and Asia) is provided as isolines plotted on four sets of charts for four months that represent the seasons in the Northern and Southern Hemispheres. GRA

**N91-17520#** Risoe National Lab., Roskilde (Denmark).
**AERIAL SMOKE PLUME OBSERVATIONS AND SURFACE-LAYER TURBULENCE MEASUREMENTS. PART 2: WIND AND TEMPERATURE SPECTRAL ANALYSIS. PHASE 4: DISPERSION STUDY: AMADEUS**
T. Mikkelsen, A. Hansen, R. M. Eckman, and S. Thykier-Nielsen Oct. 1990 102 p
(Contract DAJA45-88-M-0325; Proj. WIND)
(AD-A229291; RISOE-M-2861-PT-2-PHASE-4; ISBN-87-550-1630-8; ISSN-0418-6435) Avail: NTIS HC/MF A06 CSCL 04/2

This data report contains results from selected time series and spectral analyses of the turbulent wind and temperature measurements performed during the AMADEUS Smoke and Diffusion Tests of Project WIND, Phase 4, which took place near Read Bluff, California, during the period between 3 Sep. and 7 Oct. 1985. Part 2 of this study provided time series plots of the turbulent (10 Hz block-averaged) wind and temperature signals as recorded by sonic-anemometers/thermometers at the 7-m level above the Meadow Brook Valley floor during the AMADEUS trials. The time series are further processed into energy spectra for the three wind components (u', r', w') and fluctuating temperature (T') and are presented together with their relevant scaling parameters calculated by the correlation method. The time series and spectra provide flow and diffusion modellers of the AMADEUS experiments with an insight in the turbulent scales and energies most responsible for the observed flow and diffusion processes. They also provide high-resolution boundary-layer flow and turbulence measurements for model simulation of the individual experiments. GRA

# 48 OCEANOGRAPHY

Includes biological, dynamic, and physical oceanography; and marine resources.

For related information see also *43 Earth Resources and Remote Sensing.*

**N91-17521#** Naval Oceanographic and Atmospheric Research Lab., Bay Saint Louis, MS. Oceanography Div.
**XCTD TEST: RELIABILITY AND ACCURACY STUDY (XTRAS) Final Report**
Z. R. Hallock and W. J. Teague Sep. 1990 37 p
(AD-A227527; NOARL-TN-69) Avail: NTIS HC/MF A03 CSCL 08/3

In May to June 1990 a test and evaluation of the newly developed XCTD (expendable conductivity, temperature, depth) probe was conducted in a region northeast of Barbados, where ideal conditions exist for such a test. Thirty-six XCTD probes were launched concurrently with nine CTD casts for intercomparison. The existing fall-rate equation (FRE) was found to be inadequate and new coefficients were computed by regression using the CTD data. After recalculating XCTD depths, simultaneous drops show significant probe-to-probe difference, indicating a nonsystematic difference in (primarily) the linear term in the FRE for each probe. Examination of temperature and conductivity shows a significant systematic offset of the XCTDs relative to the CTD, suggesting a calibration error. In addition, many of the probes exhibited huge, positive conductivity excursions indicative of conductivity cell malfunction. Sippican Ocean Systems has indicated that the cell malfunctions and the calibration problems are correctable, but it is not clear if there is a solution for the residual depth error. GRA

**N91-17522#** National Geodetic Survey, Rockville, MD.
**M2 TIDE FROM GEOSAT ALTIMETRY**
C. A. Wagner Jun. 1990 15 p
(PB91-105171; NOAA-TM-NOS-NGS-53) Avail: NTIS HC/MF A03 CSCL 08C

More than 2 million global Geostat altimeter observations taken in 1986 to 1988 were analyzed for the M2 tide at overlapping points in its Exact Repeat Mission (ERM). The results are compatible with Schwiderski's 1980 tide-gage-plus-theory model at a level of 6 cm (rms discrepancy). The gross features of that model (amphidromes and highs) are unchanged. The altimeter solutions are for about 1,000 independent time series, each covering separate 5 by 5 degree areas of the deep oceans. They were calibrated through two roughly equal and independent subset analyses employing different arcs of the ERM configuration. Examination of the longest full series (108 records) shows that with further densification in time, significant correction to many other ocean tidal components will be possible. GRA

**N91-17523#** EG and G Washington Analytical Services Center, Inc., Waltham, MA.
**NORTHERN CALIFORNIA COASTAL CIRCULATION STUDY: RESULTS OF THE PILOT PROGRAM: EXECUTIVE SUMMARY Progress Report**
Bruce A. Magnell, John F. Borchardt, Cheryl L. Greengrove, Clifton D. Winant, Nancy A. Bray, and Clive E. Dorman Aug. 1989 24 p
(Contract MMS-14-12-0001-30312)
(PB90-261660; NCCCS-89-5; OCS/MMS-89/0011) Avail: NTIS HC/MF A03 CSCL 08C

The executive summary is presented for the first major analysis report of the Northern California Coastal Curvulation Study (NCCCS). NCCCS is a 5-year physical oceanographic study designed to describe the circulation on the continental shelf and upper slope between San Francisco and the Oregon Border. The major observational elements of the pilot program included near-surface and subsurface current, temperature, and bottom pressure time series measurements using moored instruments, seasonal hydrographic quasi-synoptic mapping surveys, seasonal surface current surveys using a dense array of Lagrangian drifters, and ancillary data sets including satellite imagery, meteorological variables, and sea-level records. Author

**N91-17524#** EG and G Washington Analytical Services Center, Inc., Waltham, MA.
**NORTHERN CALIFORNIA COASTAL CIRCULATION STUDY: RESULTS OF THE PILOT PROGRAM Progress Report**
Bruce A. Magnell, John F. Borchardt, Cheryl L. Greengrove, Clifton D. Winant, Nancy A. Bray, Clive E. Dorman, and Robert J. Bernstein Aug. 1989 270 p Sponsored in part by Minerals Management Service, Los Angeles, CA
(Contract MMS-14-12-0001-30312)
(PB90-261678; NCCCS-89-2; OCS/MMS-89/0008) Avail: NTIS HC/MF A12 CSCL 08C

The analysis report of the Northern California Coastal Circulation Study (NCCCS) is presented. NCCCS is a 5-year physical oceanographic study designed to describe the circulation on the continental shelf and upper slope between San Francisco and the Oregon border. The NCCCS pilot program (March to August 1987) Eulerian, Lagrangian, and hydrographic observations and interpretations are presented. Recommendations for the main program based on the pilot program results are also included. The NCCCS field measurement program consists generally of near-surface and subsurface current, temperature, and bottom pressure time series measurements using moored instruments, seasonal hydrographic surveys, and seasonal surface current surveys using a dense array of Lagrangian drifters. These direct observations are supported by collection of meteorological, satellite, sea level, and historical data from other sources. Author

**N91-17525#** Naval Oceanographic and Atmospheric Research Lab., Bay Saint Louis, MS. Remote Sensing Branch.
**SEA ICE LEAD STATISTICS FROM SATELLITE IMAGERY OF THE LINCOLN SEA DURING THE ICESHELF ACOUSTIC EXERCISE, SPRING, 1990**
F. M. Fetterer, A. E. Pressman, and R. L. Crout (Planning Systems, Inc., Slidell, LA.) Jul. 1990 133 p
(AD-A228735; NOARL-TN-50) Avail: NTIS HC/MF A07 CSCL 08/12

During March and April of 1990, the Remote Sensing Branch collected Advanced Very High Resolution Radiometer (AVHRR) satellite imagery of the Lincoln Sea and Fram Strait in support of the ICESHELF and ICEX acoustic exercises. The Lincoln Sea imagery was analyzed for sea ice lead statistics using a new method based on the Hough transform. Products of the analysis such as lead orientation rose diagrams, lead spacing statistic, and the area covered by leads, are presented e along with the imagery from which the products were derived. Icemotion vectors for three time periods produced by an automated ice motion algorithm are also shown. Imagery of the Fram Strait is included in the appendix. GRA

**N91-17526#** Naval Oceanographic and Atmospheric Research Lab., Bay Saint Louis, MS.
**A 1/8 DEGREE MODEL OF THE NORTH PACIFIC OCEAN**
H. E. Hurlburt, E. J. Metzger, A. J. Wallcraft, and P. J. Hogan (Sverdrup Technology, Inc., Bay Saint Louis, MS.) 1990 3 p
(AD-A228957; NOARL-AB-90-323-113) Avail: NTIS HC/MF A01 CSCL 08/3

Results from a 1/8 degree Pacific Ocean model (.125 degree, .176 degree resolution lat, long for each variable) are compared with results from several versions of a model with 1/4 degree resolution. All of the models are layered primitive equation, cover the Pacific Ocean north of 20S, include marginal seas, and have a free surface. The 1/8 degree model has 2 layers and realistic topography. The versions of the 1/4 degree model are 1.5 and 3.5 layer reduced gravity and 2-layer finite depth with realistic topography or a flat bottom. These models are used to show (1) the effects of horizontal resolution and vertical structure on flow instabilities, and (2) the relative importance of time-varying wind and flow instabilities in producing a time dependent oceanic response. GRA

**N91-17527#** Naval Postgraduate School, Monterey, CA. Dept. of Oceanography.
**TRANSPOLAR SEA ICE DRIFT IN THE VICINITY OF THE YERMAK PLATEAU AS OBSERVED BY ARCTEMIZ 86 BUOYS M.S. Thesis**
Paul Joseph Hoffman Mar. 1990 99 p
(AD-A228985) Avail: NTIS HC/MF A05 CSCL 08/3

Strong diurnal tidal currents, in a region dominated by semidiurnal tidal surface displacements, were observed in the record of ARCTEMIZ 1986 buoys as they drifted over the Yermak Plateau, a submarine feature northwest of Svalbard. Similar diurnal currents in this area were first observed from observations taken during the FRAM III and FRAM IV ice station drift experiments. Selective enhancement of topographic vorticity waves by resonant forcing from the K sub 1 diurnal tide over the steeply sloping northern, northwestern and western flanks of the plateau is forwarded as an explanation for these anomalously strong diurnal currents. Diurnal were observed in the trajectories of two buoys while they were over the northern flank of the Yermak Plateau. These loops were similar to those observed during MIZEX 84. The loops occurred during diurnal clockwise velocity peaks which have the same periodicity as the fortnightly (spring-neap) beat of surface height inequality caused by the superposition of the two principal semidiurnal tides. Sea ice forced by the added convergent grinding motion arising from these enhanced diurnal clockwise currents should have a surface morphology observably different from ice which did not flow through this area, i.e., that which passes through Fram Strait to the west of the Yermak Plateau. GRA

**N91-17528#** Naval Oceanographic and Atmospheric Research Lab., Bay Saint Louis, MS. Remote Sensing Branch.
**DIURNAL OCEAN SURFACE LAYER MODEL VALIDATION Final Report**
Jeffrey D. Hawkins, Douglas A. May, and Fred Abell, Jr. (Sverdrup Technology, Inc., Bay Saint Louis, MS.) May 1990 23 p Sponsored by Space and Naval Warfare Systems Command
(AD-A229010; NOARL-3) Avail: NTIS HC/MF A03 CSCL 08/3

The diurnal ocean surface layer (DOSL) model at the Fleet Numerical Oceanography Center forecasts the 24-hour change in a global sea surface temperatures (SST). Validating the DOSL model is a difficult task due to the huge areas involved and the lack of in situ measurements. Therefore, this report details the use of satellite infrared multichannel SST imagery to provide day and night SSTs that can be directly compared to DOSL products. This water-vapor-corrected imagery has the advantages of high thermal sensitivity (0.12 C), large synoptic coverage (nearly 3000 km across), and high spatial resolution that enables diurnal heating events to be readily located and mapped. Several case studies in the subtropical North Atlantic readily show that DOSL results during extreme heating periods agree very well with satellite-imagery-derived values in terms of the pattern of diurnal warming. The low wind and cloud-free conditions necessary for these events to occur lend themselves well to observation via infrared imagery. Thus, the normally cloud-limited aspects of satellite imagery do not come into play for these particular environmental conditions. The fact that the DOSL model does well in extreme events is beneficial from the standpoint that these cases can be associated with the destruction of the surface acoustic duct. This so-called afternoon effect happens as the afternoon warming of the mixed layer disrupts the sound channel and the propagation of acoustic energy. GRA

# 51 LIFE SCIENCES (GENERAL)

**N91-17529#** Arizona State Univ., Tempe. Dept. of Physics.
**MICROWAVE RESONANCES IN DNA**
S. M. Lindsay Aug. 1990 29 p Sponsored in part by Health Effects Research Lab., Research Triangle Park, NC
(Contract EPA-68-02-4105)
(PB90-261520; EPA/600/1-90/007) Avail: NTIS HC/MF A03 CSCL 06C

Spectroscopic studies are described of DNA which were undertaken to better understand a physical basis for microwave absorption by this molecule. Three types of studies are described. The low frequency scattered light spectrum of DNA was studied by two methods. First, Raman scattering of the vibrational modes of DNA films was studied down to about 4 wavenumbers/cm using a high contrast grating monochrometer. The lowest lying vibrational mode was found at frequencies between 12 and 30/cm, depending upon the specific water content, counter-ion, and crystal structure. Second, a tandem interferometer was used to study the spectrum from about 0.1 to 10/cm (3 to 300 GHz). Studies of Li-DNA films and solutions of the plasmid pUC8 found no evidence of GHz resonances in the scattered light spectrum or in the Brillouin linewidths. The coupling of GHz acoustic modes to the hydration shell of DNA was studied via a coupled mode analysis of Brillouin spectra. The primary hydration shell relaxes at about 40 ps at room temperature and might permit resonances at frequencies between 20 and 200 GHz. However, non were observed. Attempts to repeat experiments that appeared to show a resonance mode near 0.6 GHz were unsuccessful. Author

**N91-17530#** Corvallis Environmental Research Lab., OR.
**BIODIVERSITY AND HUMAN IMPACTS**
J. R. Barker, S. Henderson, R. F. Noss, and D. T. Tingey 1990 40 p Prepared in cooperation with NSI Technology Services Corp., Corvallis, OR
(PB90-263963; EPA/600/D-90/144) Avail: NTIS HC/MF A03 CSCL 06C

The basic issue that drives all concerns about biodiversity is the accelerating and irreplaceable loss of genes, species, populations, and ecosystem through environmental degradation such as deforestation, strip mining and other developmental projects. Associated with these losses are reduced options for cultural and biological adaptation to an uncertain and ever changing environment; possible disruption of essential ecological processes and services; and loss of products obtained from nature (presently or potentially). In addition, it is suggested that species, ecosystems, and other elements of biodiversity are valuable in and of themselves and thus should be protected and enhanced. Biodiversity values can be categorized as human utilitarian; ecological utilitarian; cultural, recreational, and esthetic; and ethical or intrinsic. Author

**N91-17531*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
**A CULTURE VESSEL WITH LARGE PERFUSION AREA TO VOLUME RATIO Patent Application**
David A. Wolf, inventor (to NASA), Clarence F. Sams, inventor (to NASA), and Ray P. Schwarz, inventor (to NASA) 11 Dec. 1990 25 p
(NASA-CASE-MSC-21662-1; NAS 1.71:MSC-21662-1; US-PATENT-APPL-SN-625345) Avail: NTIS HC/MF A03 CSCL 06C

An improved bio-reactor vessel and system useful for carrying out mammalian cell growth in suspension in a culture media are presented. The main goal of the invention is to grow and maintain cells under a homogeneous distribution under acceptable biochemical environment of gas partial pressures and nutrient levels without introducing direct agitation mechanisms or associated disruptive mechanical forces. The culture chamber rotates to maintain an even distribution of cells in suspension and minimizes the length of a gas diffusion path. The culture chamber design is presented and discussed. Y.S.

**N91-17532#** Trondheim Univ. (Norway). Dept. of Physics.
**A SYSTEM ANALYTICAL AND EXPERIMENTAL STUDY OF GRAVITROPIC REACTIONS IN PLANTS Thesis**
Eli Zachariassen Jan. 1988 94 p Sponsored by Norwegian Research Council for Science and the Humanities
(ETN-91-98586) Avail: NTIS HC/MF A05

Plant movements, oscillative growth movements, and circumnutations are studied. The gravitropic response to gravitropic stimuli is described. Preliminary studies for an experiment to be performed in Spacelab are presented, where the response of Avena coleoptiles is investigated under weightlessness. The circumnutations of the Helianthus hypocotyl are dealt with. Experimental and theoretical investigations of these oscillative movements under different g levels are presented. The effects of Li(x) on circumnutations of sunflower hypocotyls are studied. The equipment used to compensate plant movements is described. Examples are given on the use of the equipment in studies of phototropic movements, circumnutations, and circadian leaf movements. ESA

# 52 AEROSPACE MEDICINE

Includes physiological factors; biological effects of radiation; and effects of weightlessness on man and animals.

**N91-17533#** Texas Univ. Health Science Center, Houston. School of Public Health.
**HYPERBARIC OXYGENATION (HBO) CLINICAL TRIALS: A REVIEW M.S. Thesis**
James Roy Knowles May 1990 48 p Sponsored by AFIT, Wright-Patterson AFB, OH
(AD-A227901; AFIT/CI/CIA-90-097) Avail: NTIS HC/MF A03 CSCL 06/5

Hyperbaric oxygenation (HBO) has been used as a medical intervention for the treatment or prophylaxis of numerous conditions in humans. There is an accumulation of pre-clinical and clinical data supporting its use in humans. It has been asserted that the clinical data are largely derived from anecdotal, uncontrolled observations. The call for reliable data from good clinical trials has sounded forth both from within and from outside the HBO community. A logical question is: What clinical trials have actually been done to assess the efficacy of HBO, how good were they, and what did they find. This thesis will present a review of HBO clinical trials which will help answer the above question. The review will identify HBO clinical trials in the general medical literature, assess their methodologic content, and list the reported efficacy of HBO in the various trials. Lastly, the review will briefly discuss its findings as they relate to future clinical research involving the use of HBO. GRA

**N91-17534#** Naval Medical Research Inst., Bethesda, MD.
**EFFECTS OF MULTIPLE COLD AIR EXPOSURES ON DELAYED MATCHING TO SAMPLE PERFORMANCE Interim Report**
David W. Armstrong and John R. Thomas 2 Apr. 1990 19 p
(AD-A228390; NMRI-90-87) Avail: NTIS HC/MF A03 CSCL 06/10

Acute exposure to moderate cold impairs delayed matching to sample (DMS) performance in both animal and man. The effect of multiple cold air (2.6 + or - 0.6 C) exposures on DMS performance was investigated. Twelve men performed the DMS task during a 45 min exposure to cold air on Day 1. Oxygen consumption (VO2) was measured concurrently. After completion of Day 1, subjects were assigned to two groups. Group W performed the DMS task on Days 2 to 11 in warm air (22 C) during a 45 min period before sitting in cold air for 45 min. Group C performed the DMS task during a 45 min exposure to cold air on days 2 to 11. On Day 12, all subjects were exposed to cold air as on Day 1. VO2 was measured concurrently on Days 4 to 8. DMS performance was significantly impaired in all subjects during exposure to cold air on Day 1 when compared to baseline DMS performance. Performance on the DMS was significantly different between the groups on Day 12. Group W performance was not different on Day 12 when compared to Day 1. Group C performance was not different from baseline on Day 12 and was significantly improved when compared to Day 1. VO2 was elevated in the cold but was not different between groups. VO2 was not different on Day 12 when compared to Day 1. DMS is affected by acute exposure to cold air. Performance on the DMS task improves with repeated cold air exposure only when the DMS task is repeatedly performed in cold air. GRA

**N91-17535#** Institute for Defense Analyses, Alexandria, VA.
**FLYING HOURS AND AIRCREW PERFORMANCE Final Report, Jul. 1987 - Dec. 1989**
Colin P. Hammon and Stanley A. Horowitz Mar. 1990 39 p
(Contract MDA903-84-C-0031)
(AD-A228582; AD-E501304; IDA-P-2379; IDA/HQ-90-35201)
Avail: NTIS HC/MF A03 CSCL 05/9

This work addresses the development of quantitative relationships between how much aircrews have flown and how well they perform important aspects of their missions. It is determined that additional flying enhances proficiency in two ways: through the short-run honing of skills and through the long-run development of mastery. Estimates of the strength of the links between flying experience and three measures of performance are developed. The measures are: bombing accuracy, the quality of landings aboard aircraft carriers, and kills in air combat maneuvering exercises. In general, it is found that while both short-run experience are important, career experience has a stronger relationship than recent experience to performance. GRA

**N91-17536#** National Inst. of Standards and Technology, Gaithersburg, MD.
**FED-X: THE NIST EXPRESS TRANSLATOR**
Stephen Nowland Clark Aug. 1990 18 p
(PB90-269507; NISTIR-4371) Avail: NTIS HC/MF A03 CSCL 08B

The product data exchange specification (PDES) is an emerging standard for the exchange of product information among various manufacturing applications. PDES includes an information model written in the Express language; other PDES-related information models are also written in Express. The National PDES Testbed and NIST has developed software to manipulate and translate Express models. The software consists of an in-memory working form and an associated Express language parser, FED-X. The design and capabilities of FED-X and the Express Working Form are discussed. GRA

**N91-17537#** Pacific Northwest Lab., Richland, WA.
**ELF (EXTREMELY-LOW-FREQUENCY) FIELD INTERACTIONS AT THE ANIMAL, TISSUE AND CELLULAR LEVELS**
T. S. Tenforde Oct. 1990 22 p Presented at the 10th Anniversary Meeting of the Bioelectrical Growth and Repair Society, Philadelphia, PA, 14-16 Oct. 1990
(Contract DE-AC06-76RL-01830)
(DE91-004807; PNL-SA-18664; CONF-9010265-1) Avail: NTIS HC/MF A03

A description is given of the fundamental physical properties of extremely-low-frequency (ELF) electromagnetic fields, and the mechanisms through which these fields interact with the human body at a macroscopic level. Biological responses to ELF fields at the tissue, cellular and molecular levels are summarized, including new evidence that ELF field exposure produces alterations in gene expression and the cytoplasmic concentrations of specific proteins. DOE

**N91-17538*#** Texas Univ., Galveston. Dept. of Otolaryngology, Physiology and Biophysics.
**INVESTIGATION OF OTOLITH RESPONSES USING GROUND BASED VESTIBULAR RESEARCH FACILITY Final Technical Report, 2 Jul. 1982 - 30 Jun. 1989**
Manning J. Correia and Tabaracci 30 Jun. 1989 8 p
(Grant NAG2-186)
(NASA-CR-187877; NAS 1.26:187877) Avail: NTIS HC/MF A02 CSCL 06P

The general goal was to examine tilt sensitivity of horizontal semicircular canal afferents. Computer programs were tested which controlled the short axis centrifuge at the Vestibular Research Facility, acquired action potentials and produced data reduction

analyses including histograms and gain and phase calculations. A pre-amplifier was also developed for the acquisition of action potentials. The data were gathered that can be used to contribute toward the understanding of the tilt sensitivity of semicircular canal afferents in the unanesthetized gerbil preparation. Author

**N91-17539#** Naval Biodynamics Lab., New Orleans, LA.
**BIBLIOGRAPHY OF SCIENTIFIC PUBLICATIONS OF THE NAVAL BIODYNAMICS LABORATORY: 1980-1990 Interim Report, 1 Jan. 1980 - 31 Aug. 1990**
4 Sep. 1990 27 p Sponsored by Naval Medical Research and Development Command, Bethesda, MD
(AD-A229030; NBDL-90R005) Avail: NTIS HC/MF A03 CSCL 06/5

This report lists all research reports, special reports, monographs, technical memoranda, joint reports, research information bulletins, journal articles, and conference proceedings published by the Naval Biodynamics Laboratory between January 1980 and August 1990. GRA

**N91-17540#** Dartmouth Coll., Hanover, NH. Dept. of Psychology.
**MULTIMODAL INTERACTIONS IN SENSORY-MOTOR PROCESSING Annual Technical Report, Jul. 1989 - Jul. 1990**
H. C. Hughes, P. A. Reuter-Lorenz, R. Fendrich, G. Nozawa, and M. S. Gazzaniga 15 Sep. 1990 91 p
(Grant AF-AFOSR-0437-89; AF Proj. 2313)
(AD-A229111; AFOSR-90-1132TR) Avail: NTIS HC/MF A05 CSCL 06/5

The saccadic control system represents a good model system to study the selection of stimulus events according to their spatial location. The present work focuses on two factors known to influence saccade latency: the presence of a fixation stimulus and the nature of the saccade target. We report evidence which suggests that fixation point offsets facilitate pre-motor stages of saccade generation (Reuter-Lorenz et al., in press; Appendix I). This idea, in conjunction with electrophysiological data, suggested that fixation offset might also facilitate saccades to acoustic targets. Experiment 1 confirmed this suggestion (Fendrich, et al. (in preparation)). The facilitatory effects of redundant stimulation via the visual and auditory modalities is examined in Experiment 2 (Nozawa et al., 1990). The data suggest significant neural summation, which we attribute to bimodal convergence onto individual cells though to mediate saccadic command functions. GRA

**N91-17541#** Texas Univ. Health Science Center, San Antonio. Dept. of Ophthalmology.
**GLARE AND AGE: ACQUISITION OF A CLINICAL DATA BASE FOR AIRCREW STANDARDS Final Report, Feb. 1988 - Jun. 1990**
Joseph M. Harrison, Chen Peng, Charles S. Ballentine, and J. Terry Yates Oct. 1990 44 p Sponsored by Southeastern Center for Electrical Engineering Education, Inc., Saint Cloud, FL
(Contract F33615-87-D-0609; AF Proj. 7755)
(AD-A229237; USAFSAM-TR-90-28) Avail: NTIS HC/MF A03 CSCL 06/4

The trend towards a significant age-related decline in contrast sensitivity that was demonstrated in subjects aged 21 to 50 in previous studies prompted a replication with a large sample size and an investigation of scattered light, measured indirectly by disability glare, as a function of age. The age related decline of contrast sensitivity was unconfirmed in the age range 21 to 50 with a large sample size, 30, in each decade. Contrast sensitivity to neither externally generated nor interference gratings changed significantly with age. The high spatial frequency cutoff derived from the contrast sensitivity to 12, 16, and 20 cycle per degree gratings did not vary as a function of age. This is consistent with the fact that we selected only those subjects with 20/20 or better visual acuity. Consistent with the lack of declining contrast sensitivity over this age range was the lack of a significant age-related increase in susceptibility to disability glare as measured by sensitivity to 4 and 12 cycles per degree gratings without and with glare. The interaction between age and glare condition was not statistically significant. Increment threshold for a low mesopic background did not change significantly as a function of age. There was a significant increase in the increment threshold limited ot the glare condition for the oldest decade in the paradigm simulating night time glare. GRA

# 53 BEHAVIORAL SCIENCES

Includes psychological factors; individual and group behavior; crew training and evaluation; and psychiatric research.

**N91-17044*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
**IN-FLIGHT CREW TRAINING**
Charles Gott, Peter Galicki, and David Shores (Barrios Technology, Inc., Houston, TX.) *In* NASA, Washington, Space Transportation Avionics Technology Symposium. Volume 2: Conference Proceedings Aug. 1990 p 581-588 (For primary document see N91-17020 09-06)
Avail: NTIS HC/MF A99 CSCL 05I

# 54 MAN/SYSTEM TECHNOLOGY AND LIFE SUPPORT

Includes human engineering; biotechnology; and space suits and protective clothing.

For related information see also *16 Space Transportation.*

**N91-17542#** Air Force Human Resources Lab., Brooks AFB, TX. Logistics and Human Factors Div.
**DESIGN EVALUATION FOR PERSONNEL, TRAINING, AND HUMAN FACTORS (DEPTH) Interim Technical Paper, Dec. 1989 - Jun. 1990**
Edward S. Boyle, Jill A. Easterly, and John D. Ianni Jul. 1990 23 p Submitted for publication
(AF Proj. 2940)
(AD-A224757; AFHRL-TP-90-57) Avail: NTIS HC/MF A03 CSCL 23/2

This paper describes a new direction in human factors research called Design Evaluation for Personnel, Training, and Human Factors (DEPTH). This research utilizes computer-aided design (CAD) man-modeling and data base technologies to foster a human-centered approach to weapon system design. The ability to graphically simulate maintenance work underlies this research. Visualizing maintenance tasks will allow more accurate and complete descriptions of human performance requirements during design. This man-modeling capability will utilize a computer graphic workstation capable of importing CAD data and will build upon technology developments of CREW CHIEF, a model of a maintenance technician developed by Air Force Human Resources Laboratory (AFHRL) and Armstrong Aerospace Medical Research Laboratory (AAMRL). Additional capabilities include detailed hand and vision models, multi-person task performance simulation, the effects of environmental, and animated simulations of complete maintenance tasks. Logistics Support Analysis (LSA), training, and personnel information will be derived from these simulations and presented in a usable format. GRA

**N91-17543#** Massachusetts Inst. of Tech., Cambridge. Artificial Intelligence Lab.
**THE CONTROL OF HUMAN ARM MOVEMENT: MODELS AND MECHANICAL CONSTRAINTS Ph.D. Thesis**
David J. Bennett Jun. 1990 202 p
(Contracts N00014-86-K-0180; N00014-85-K-0124; NIH-AM-26710)
(AD-A228690; AI-TR-1234) Avail: NTIS HC/MF A10 CSCL 05/8

The role is studied of structured models in autonomous motor

learning. Any autonomous system, such as the human motor system, has only the internal consistency of its various sensors to rely upon for model building (learning). To study the possibility of learning structured models from internal consistency constraints, the specific problem of learning the kinematic parameters (relative link orientations and length) of general revolute joint manipulators is explored. First it is noted that a manipulator may form a mobile closed kinematic chain when interacting with the environment, if it is redundant with respect to the task degrees of freedom (DOFs) at the endpoint. Then it is demonstrated that if the mobile closed chain assumes a number of configurations, then loop consistency equations permit joint angle readings; endpoint sensing is not required. GRA

**N91-17544#** Brookhaven National Lab., Upton, NY. Dept. of Nuclear Energy.
**ADVANCED HUMAN-SYSTEM INTERFACE DESIGN REVIEW GUIDELINES**
John M. OHara 1990 18 p Presented at the 18th Water Reactor Safety Information Meeting, Gaithersburg, MD, 22-24 Oct. 1990
(Contract DE-AC02-76CH-00016)
(DE91-005439; BNL-NUREG-45454; CONF-9010185-16) Avail: NTIS HC/MF A03

Advanced, computer-based, human-system interface designs are emerging in nuclear power plant (NPP) control rooms. These developments may have significant implications for plant safety in that they will greatly affect the ways in which operators interact with systems. At present, however, the only guidance available to the U.S. Nuclear Regulatory Commission (NRC) for the review of control room-operator interfaces, NUREG-0700, was written prior to these technological changes; therefore, it is not designed to address them. The objective of the project reported in this paper is to develop an Advanced Control Room Design Review Guideline for use in performing human factors reviews of advanced operator interfaces. This guideline will be implemented, in part, as a portable, computer-based, interactive document for field use. The paper describes the overall guideline development methodology, the present status of the document, and the plans for further guideline testing and development. DOE

**N91-17545#** Anacapa Sciences, Inc., Fort Rucker, AL.
**TASK ANALYSIS AND WORKLOAD PREDICTION MODEL OF THE MH-60K MISSION AND A COMPARISON WITH UH-60A WORKLOAD PREDICTIONS. VOLUME 2: APPENDIXES A THROUGH G Interim Report, Dec. 1988 - Apr. 1990**
Carl R. Bierbaum and David B. Hamilton Oct. 1990 192 p
(Contract MDA903-87-C-0523; DA Proj. 2Q2-63007-A-793)
(AD-A228947; ASI90-328-90-II-VOL-2; ARI-RN-91-01-VOL-2)
Avail: NTIS HC/MF A09 CSCL 01/3

For this research, a mission scenario was used to conduct a comprehensive task analysis for MH-60K operations. The analysis used a top-down approach to identify 5 phases, 15 segments, 71 functions, and 230 tasks for the mission. Also, the crewmember performing each task was identified, and estimates of the task duration and the sensory, cognitive, and psychomotor workload associated with the tasks were derived. The mission/task/workload analysis data were used to develop a computer model of workload for MH-60K crewmembers. The model used a bottom-up approach to build mission functions from tasks and mission segments from functions. Decision rules were written to specify the procedure for combining tasks into functions and functions into segments. The model permitted an analysis of total workload experienced by the pilot and copilot in the performance of both sequential and concurrent tasks. The predicted workload for the MH-60K pilot and copilot was compared to the UH-60A baseline workload prediction to determine the impact of the MH-60K advanced technology. The comparison indicated very little difference in the predicted workload for the pilot and lower predicted workload for the copilot in the MH-60K. GRA

**N91-17546#** Idaho National Engineering Lab., Idaho Falls.
**EXAMINING HUMAN-SYSTEM INTERACTIONS: THE HSYS (HUMAN SYSTEM) METHODOLOGY**
Susan G. Hill, Jerry L. Harbour, Christopher Sullivan, and Bruce P. Hallbert 1990 5 p Presented at the 34th Human Factors Society Conference, Orlando, FL, 8-12 Oct. 1990
(Contract DE-AC07-76ID-01570)
(DE91-006150; EGG-M-89088; CONF-9010155-4) Avail: NTIS HC/MF A01

The human-system methodology (HSYS) is a model-based methodology developed to examine the many factors which influence human-system interactions. HSYS is built around a linear model of human performance, called the Input-Action model, which describes five sequential steps: Input Detection, Input Understanding, Action Selection, Action Planning, and Action Execution. HSYS is structured in an hierarchical tree which presents a logical structure for examining potential areas where human performance, hardware or other system components are less than adequate. The HSYS tree consists of five major branches which correspond to the five major components of the Input-Action model. Initial validation was begun by studying accident reports via HSYS and identifying sources of error. The validation process has continued with accident investigations in operational settings. DOE

**N91-17048*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
**PAYLOAD DEPLOYMENT SYSTEMS AND ADVANCED MANIPULATORS**
*In* NASA, Washington, Space Transportation Avionics Technology Symposium. Volume 2: Conference Proceedings Aug. 1990 p 657-662 (For primary document see N91-17020 09-06)
Avail: NTIS HC/MF A99 CSCL 05H

# 55 SPACE BIOLOGY

Includes exobiology; planetary biology; and extraterrestrial life.

No abstracts in this category.

# 59 MATHEMATICAL AND COMPUTER SCIENCES (GENERAL)

No abstracts in this category.

# 60 COMPUTER OPERATIONS AND HARDWARE

Includes hardware for computer graphics, firmware, and data processing.

For components see *33 Electronics and Electrical Engineering.*

**N91-17547#** University of Southern California, Marina del Rey. Information Sciences Inst.
**A RESEARCH PROGRAM IN COMPUTER TECHNOLOGY Annual Technical Report, 1 Jul. 1986 - 30 Nov. 1987**
Keith W. Uncapher Jul. 1990 134 p
(Contract MDA903-81-C-0335; ARPA Order 4242)
(AD-A224924; ISI/SR-88-255) Avail: NTIS HC/MF A07 CSCL 12/7

This report summarizes the research performed by USC/Information Sciences Institute from July 1, 1986 to November 30, 1987, for the Defense Advanced Research Projects Agency. The research is focused on the development of computer science and technology, which is expected to have a high DoD/military impact. GRA

**N91-17548#** Department of the Navy, Washington, DC.
**TOROIDAL COMPUTER MEMORY FOR SERIAL AND PARALLEL PROCESSORS Patent Application**
Allen D. Parks, inventor (to Navy) and James C. Perry, inventor (to Navy) 26 Jun. 1990 13 p
(AD-D014631; US-PATENT-APPL-SN-546595; NAVY-CASE-72302) Avail: NTIS HC/MF A03 CSCL 12/6

The toroidal computer memory system accomplishes its stated objectives by utilizing selectable memory paths to store and retrieve data. The memory paths are designed to model paths on the surface of a torus. By using the mathematical properties of the toroidal paths, the memory system is configured to store or retrieve data corresponding to points on the memory paths. These paths can be obtained in a single access compared to the multiple accesses typically required by conventional computer memory. Random Access Memory (RAM) chips, multi-port RAM integrated circuits, optical storage devices, or specially designed chips can be used as the storage/retrieval media for the toroidal computer memory system. GRA

**N91-17549#** Naval Surface Warfare Center, Silver Spring, MD. Underwater Systems Dept.
**EVALUATION PROCESS REPORT FOR NEXT GENERATION COMPUTER RESOURCES OPERATING SYSTEMS INTERFACE BASELINE SELECTION**
Steven L. Howell, ed. 7 May 1990 53 p
(AD-A228594; NAVSWC-TR-90-248) Avail: NTIS HC/MF A04 CSCL 12/7

The Operating Systems Standards Working Group (OSSWG) has been tasked to evolve an interface standard for operating systems. This document defines the process by which the OSSWG will make a recommendation of a baseline interface specification to the Next Generation Computer Resources (NGCR) program office. This baseline specification will be derived from one or more existing operating system implementations, specifications, or standards. GRA

**N91-17550#** Oak Ridge National Lab., TN. Engineering Physics and Mathematics Div.
**A USER'S GUIDE TO PICL: A PORTABLE INSTRUMENTED COMMUNICATIONS LIBRARY**
G. A. Geist, M. T. Heath, B. W. Peyton, and P. H. Worley Oct. 1990 26 p
(Contract DE-AC05-84OR-21400)
(DE91-005648; ORNL/TM-11616) Avail: NTIS HC/MF A03

This report is the portable instrumented communication library (PICL) user's guide. It contains an overview of PICL and how it is used. Examples in C FORTRAN are included. PICL is a subroutine library that can be used to develop parallel programs that are portable across several distributed-memory multiprocessors. PICL provides a portable syntax for key communication primitives and related system calls. It also provides portable routines to perform certain widely-used, high-level communication operations, such as global broadcast and global summation. Finally, PICL provides execution tracing that can be used to monitor performance or to aid in debugging. DOE

**N91-17551#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**A WHOLE WORD AND NUMBER READING MACHINE BASED ON TWO DIMENSIONAL LOW FREQUENCY FOURIER TRANSFORMS Ph.D. Thesis**
Mark Allen OHair Dec. 1990 135 p
(AD-A229036; AD-E501305; AFIT/DS/ENG/90D-01) Avail: NTIS HC/MF A07 CSCL 14/3

The Fourier transform is investigated as a means for developing an optical reader capable of reading a large vocabulary without segmenting the image of a word into individual characters. The reader is capable of reading printed and cursive font styles, is scale invariant, and is substantially insensitive to noise. The image of a particular word is treated as a single symbol; the two dimensional low frequency Fourier coefficients (assuming n coefficients are calculated) define the word's location on an n dimensional hypersphere of unit radius. The distance between individual locations (words) categorizes similar and dissimilar words. The smaller the distance, the more similar images are. Multiple images of a word using various font styles form a unique cluster on the surface of the hypersphere. The distance between clusters (different words) is greater than the distance across a cluster (same word in different font styles). Therefore, by using the centroid of these clusters to build a library of words, input or test words match to the nearest cluster centroid using a minimum distance calculation. This algorithm is capable of correctly recognizing at least 5000 words using 24 various font styles (120,000 individual images). GRA

**N91-17552#** Duke Univ., Durham, NC. Dept. of Computer Science.
**COMPUTATIONAL COMPLEXITY AND EFFICIENCY IN ELECTRO-OPTICAL COMPUTING SYSTEMS Annual Technical Report, 1 Apr. 1989 - 26 Jun. 1990**
John H. Reif 1 Jul. 1990 38 p
(Grant AF-AFOSR-0386-87; AF Proj. 2305)
(AD-A229195; AFOSR-90-1080TR) Avail: NTIS HC/MF A03 CSCL 09/5

The research approach and objectives were to develop robust theoretical model for a wide class of electro-optical systems; to extend the known capabilities, by design of new, more efficient algorithms for electro-optical computing using less time, volume, and energy; to develop efficient algorithms that use optimal combinations of time, volume, and energy on electro-optical computing systems; to determine the fundamental theoretical limitations and capabilities of electro-optical computing systems; and to determine lower bounds on tradeoffs between volume, time and other resources (such as energy) of any electro-optical computing systems to solve fundamental problems. GRA

**N91-17553#** Rome Air Development Center, Griffiss AFB, NY.
**CLOSED LOOP DIGITAL AND COMPUTER CONTROL OF AN ULTRAGRAVIMETRIC MICROBALANCE Report, Oct. 1986 - Apr. 1990**
Joseph V. Beasock Oct. 1990 138 p
(AF Proj. 2338)
(AD-A229276; RADC-TR-90-320) Avail: NTIS HC/MF A07 CSCL 12/6

The development is summarized of a control system for an ultragravimetric microbalance. Included are the different control methodologies investigated and the characteristics of each. These methodologies are based on two types of control systems: one is a digital system implemented totally in hardware and the other a computer controlled system. The intent of the project was to replace the existing analog controller with a system that was more stable, had better response to transient conditions, was less temperature sensitive and could be operated unattended for long periods of time. Much of the work to date, on the computer controlled system, has concentrated on bringing the balance to equilibrium quickly and reliably, maintaining equilibrium once achieved and reliably tracking mass change. Data analysis and reduction techniques are still being developed and evaluated. As yet, there is no indication of the ultimate sensitivity obtainable with a computer controlled system, but a sensitivity of 0.2 microgram, with a sample mass of 5 grams, should be rountinely obtainable. In addition to the electrical/electronic characteristics, there is some discussion of the mechanical characteristics that affect the performance of the balance. But because of time constraints, the mechanical aspects are not discussed in detail. An adsorption/desorption experiment, on a devitrifying, microcircuit package, sealing glass (type 75-83), is presented to demonstrate the use of the system and illustrate the mass tracking behavior. GRA

**N91-17554#** Sandia National Labs., Albuquerque, NM. Parallel Computational Sciences Div.
**ITERATIVE METHODS FOR NONSYMMETRIC SYSTEMS ON MIMD MACHINES**
John N. Shadid and Ray S. Tuminaro 16 Oct. 1990 3 p Presented at the SIAM Conference on Supercomputing, Houston, TX, 22-24 Mar. 1991
(Contract DE-AC04-76DP-00789)
(DE91-002780; SAND-90-2698C; CONF-910326-1) Avail: NTIS HC/MF A01

A wide variety of physical phenomena arising within many scientific disciplines can be described by systems of coupled partial differential equations (PDEs). The numerical approximation of these PDEs often involves the solution of a system of algebraic equations (possibly nonlinear) which are typically large, sparse and nonsymmetric. The increasing computational demands required by the solution of such complex scientific applications has motivated the current direction toward large-scale parallel computers. We, therefore, consider solution techniques of representative systems of equations on large scale multiple instruction/multiple data (MIMD) machines. Our primary emphasis in this study is the evaluation of iterative methods for the solution of nonsymmetric systems. In particular, we discuss two Krylov subspace methods, the conjugate gradient squared algorithm (CGS) and the generalized minimum residual method (GMRES), along with the multigrid algorithm (MG) on massively parallel MIMD architectures. The focus of this evaluation considers the performance of various algorithm and implementation variations over a broad selection of problems using a parallel machine. DOE

**N91-17555#** Los Alamos National Lab., NM. Cognitive Systems Engineering Group.
**CD-ROM (COMPACT DISC-READ ONLY MEMORY): A DELIVERY MEDIUM FOR CBT (COMPUTER-BASED TRAINING)**
Allen L. Luettgen, F. Kay Houghton, and Andrew E. Andrews 1991 20 p Presented at the TITE 1991: 9th Annual Technology and Innovations in Training and Education Conference, San Antonio, TX, 11-15 Mar. 1991
(Contract W-7405-eng-36)
(DE91-004831; LA-UR-90-3784; CONF-910371-2) Avail: NTIS HC/MF A03

Computer-based training (CBT) development has evolved from electronic page turners to a sophisticated instructional environment. The use of numerous large image files, large digital audio files, and complex computer-generated graphics files places great demands on a system's capacity for binary storage (disk space). One solution is the use of compact disc-read only memory (CD-ROM). The explosive growth of CD-ROM players in the marketplace makes CD-ROM a viable delivery medium for CBT. Recently, a CBT package for radiation protection technicians at Los Alamos National Laboratory was produced on CD-ROM. The course is delivered on a multimedia system consisting of the following: MS DOS-based computer, CD-ROM player, high-resolution video graphics array monitor, scanned color images with graphic overlays, digital audio, and mouse interface. This paper will allow the reader to assess the appropriateness of CD-ROM for a specific project, report on lessons learned from the RPT project, demonstrate that CD-ROM is within reach of the average CBT developer, and provide guidelines for successfully developing CD-ROM based CBT. This paper can serve as a basic primer on how to adapt CD-ROM as a CBT medium. Some of the technical aspects that are discussed are listed here: CD-ROM basics for CBT development, availability of low-cost development environments, file organization, optimization of CD-ROM response times, effective use of digital audio and still frame graphics, and animation with CD-ROM. DOE

**N91-17563*#** Nebraska Univ., Lincoln. Dept. of Computer Science and Engineering.
**MAFT: THE MULTICOMPUTER ARCHITECTURE FOR FAULT-TOLERANCE**
Roger M. Kieckhafer *In* NASA, Langley Research Center, NASA Formal Methods Workshop, 1990 Nov. 1990 52 p (For primary document see N91-17559 09-61)
Avail: NTIS HC/MF A22 CSCL 09B

**N91-17567*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
**HIGH LEVEL DESIGN PROOF OF A RELIABLE COMPUTING PLATFORM**
Ben L. DiVito, Ricky W. Butler, and James L. Caldwell *In its* NASA Formal Methods Workshop, 1990 Nov. 1990 28 p (For primary document see N91-17559 09-61)
Avail: NTIS HC/MF A22 CSCL 09B

**N91-17572*#** Idaho Univ., Moscow. Dept. of Computer Science.
**GENERIC INTERPRETERS AND MICROPROCESSOR VERIFICATION**
Phillip J. Windley *In* NASA, Langley Research Center, NASA Formal Methods Workshop, 1990 Nov. 1990 33 p (For primary document see N91-17559 09-61)
(Contract NAS1-18586)
Avail: NTIS HC/MF A22 CSCL 09B

**N91-17573*#** Royal Signals and Radar Establishment, Malvern (England).
**VIPER PROJECT**
John Kershaw *In* NASA, Langley Research Center, NASA Formal Methods Workshop, 1990 Nov. 1990 24 p (For primary document see N91-17559 09-61)
Avail: NTIS HC/MF A22 CSCL 09B

**N91-17574*#** SRI International Corp., Menlo Park, CA. Computer Science Lab.
**MECHANICAL PROOFS OF FAULT-TOLERANT CLOCK SYNCHRONIZATION**
N. Shankar *In* NASA, Langley Research Center, NASA Formal Methods Workshop, 1990 Nov. 1990 37 p (For primary document see N91-17559 09-61)
Avail: NTIS HC/MF A22 CSCL 09B

# 61 COMPUTER PROGRAMMING AND SOFTWARE

Includes computer programs, routines, alogorithms, and specific applications, e.g., CAD/CAM.

**N91-17556#** Sandia National Labs., Albuquerque, NM.
**ARCHIMEDES: AN EXPERIMENT IN AUTOMATING MECHANICAL ASSEMBLY**
David Strip and Anthony A. Maciejewski (Purdue Univ., West Lafayette, IN.) 1990 7 p Presented at the ISRAM 1990: International Symposium on Robotics and Automation, Vancouver, British Columbia, 18-20 Jul. 1990
(Contract DE-AC04-76DP-00789)
(DE90-009001; SAND-89-2561C; CONF-900780-1) Avail: NTIS HC/MF A02

Archimedes is a prototype mechanical assembly system which generates and executes robot assembly programs from a CAD model input. The system addresses the unrealized potential for flexibility in robotic mechanical assembly applications by automating the programming task. Input is a solid model of the finished assembly. Using this model, Archimedes deduces geometric assembly constraints and then produces an assembly plan that satisfies the geometric constraints, as well as other constraints such as stability and accessibility. A retargetable plan compiler converts the generic plan into robot and cell specific code, including recognition routines for a vision system. In the prototype system the code is executed in a workcell containing an Adept Two robot, a vision system, and other parts handling equipment. DOE

**N91-17557*#** Southwest Research Inst., San Antonio, TX.
**CONTINUATION OF RESEARCH INTO SOFTWARE FOR SPACE OPERATIONS SUPPORT, VOLUME 1 Final Report**
Mark D. Collier, Ronnie Killough, and Nancy L. Martin 30 Nov. 1990 436 p
(Grant NAG9-388; SwRI Proj. 05-2984)
(NASA-CR-187661; NAS 1.26:187661) Avail: NTIS HC/MF A19 CSCL 09B

A prototype workstation executive called the Hardware Independent Software Development Environment (HISDE) was developed. Software technologies relevant to workstation executives were researched and evaluated and HISDE was used as a test bed for prototyping efforts. New X Windows software concepts and technology were introduced into workstation executives and related applications. The four research efforts performed included: (1) Research into the usability and efficiency of Motif (an X Windows based graphic user interface) which consisted of converting the existing Athena widget based HISDE user interface to Motif demonstrating the usability of Motif and providing insight into the level of effort required to translate an application from widget to another; (2) Prototype a real time data display widget which consisted of research methods for and prototyping the selected method of displaying textual values in an efficient manner; (3) X Windows performance evaluation which consisted of a series of performance measurements which demonstrated the ability of low level X Windows to display textural information; (4) Convert the Display Manager to X Window/Motif which is the application used by NASA for data display during operational mode. Author

**N91-17558*#** Southwest Research Inst., San Antonio, TX.
**CONTINUATION OF RESEARCH INTO SOFTWARE FOR SPACE OPERATIONS SUPPORT: CONVERSION OF THE DISPLAY MANAGER TO X WINDOWS/MOTIF, VOLUME 2 Final Report**
Mark D. Collier, Ronnie Killough, and Nancy L. Martin 30 Nov. 1990 726 p
(Grant NAG9-388; SwRI Proj. 05-2984)
(NASA-CR-187662; NAS 1.26:187662) Avail: NTIS HC/MF A99 CSCL 09B

NASA is currently using a set of applications called the Display Builder and Display Manager. They run on Concurrent systems and heavily depend on the Graphic Kernel System (GKS). At this time however, these two applications would more appropriately be developed in X Windows, in which a low X is used for all actual text and graphics display and a standard widget set (such as Motif) is used for the user interface. Use of the X Windows will increase performance, improve the user interface, enhance portability, and improve reliability. Prototype of X Window/Motif based Display Manager provides the following advantages over a GKS based application: improved performance by using a low level X Windows, display of graphic and text will be more efficient; improved user interface by using Motif; Improved portability by operating on both Concurrent and Sun workstations; and Improved reliability. Author

**N91-17559*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
**NASA FORMAL METHODS WORKSHOP, 1990**
Ricky W. Butler, comp. Nov. 1990 504 p Workshop held in Hampton, VA, 20-23 Aug. 1990; sponsored by NASA, Washington (NASA-CP-10052; NAS 1.55:10052) Avail: NTIS HC/MF A22 CSCL 09B

The workshop brought together researchers involved in the NASA formal methods research effort for detailed technical interchange and provided a mechanism for interaction with representatives from the FAA and the aerospace industry. The workshop also included speakers from industry to debrief the formal methods researchers on the current state of practice in flight critical system design, verification, and certification. The goals were: define and characterize the verification problem for ultra-reliable life critical flight control systems and the current state of practice in industry today; determine the proper role of formal methods in addressing these problems, and assess the state of the art and recent progress toward applying formal methods to this area. For individual titles, see N91-17560 through N91-17578.

**N91-17560*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
**DIGITAL AVIONICS: A CORNERSTONE OF AVIATION** **c06**
Cary R. Spitzer *In its* NASA Formal Methods Workshop, 1990 Nov. 1990 24 p (For primary document see N91-17559 09-61)
Avail: NTIS HC/MF A22 CSCL 09B

Digital avionics is continually expanding its role in communication (HF and VHF, satellite, data links), navigation (ground-based systems, inertial and satellite-based systems), and flight-by-wire control. Examples of electronic flight control system architecture, pitch, roll, and yaw control are presented. Modeling of complex hardware systems, electromagnetic interference, and software are discussed. Y.S.

**N91-17561*#** Boeing Commercial Airplane Co., Seattle, WA.
**LIFE-CRITICAL DIGITAL FLIGHT CONTROL SYSTEMS** **c08**
James McWha *In* NASA, Langley Research Center, NASA Formal Methods Workshop, 1990 Nov. 1990 22 p (For primary document see N91-17559 09-61)
Avail: NTIS HC/MF A22 CSCL 01C

Digital autopilot systems were first used on commercial airplanes in the late 1970s. The A-320 airplane was the first air transport airplane with a fly-by-wire primary flight control system. On the 767-X (777) airplane Boeing will install all fly-by-wire flight controls. Activities related to safety, industry status and program phases are discussed. Y.S.

**N91-17562*#** Boeing Military Airplane Development, Seattle, WA.
**ADVANCED EMBEDDED PROCESSING: PRESENT AND FUTURE** **c05**
Gerald C. Cohen *In* NASA, Langley Research Center, NASA Formal Methods Workshop, 1990 Nov. 1990 42 p (For primary document see N91-17559 09-61)
Avail: NTIS HC/MF A22 CSCL 01C

Integrated airframe/propulsion control system architecture is discussed. The main objectives of the program are: design and validation methodology for system architecture; system design; system specification; and small-scale system testing. Y.S.

**N91-17563*#** Nebraska Univ., Lincoln. Dept. of Computer Science and Engineering.
**MAFT: THE MULTICOMPUTER ARCHITECTURE FOR FAULT-TOLERANCE** **c60**
Roger M. Kieckhafer *In* NASA, Langley Research Center, NASA Formal Methods Workshop, 1990 Nov. 1990 52 p (For primary document see N91-17559 09-61)
Avail: NTIS HC/MF A22 CSCL 09B

Multicomputer Architecture for Fault-Tolerance (MAFT) is a loosely coupled multiprocessor system designed to achieve an unreliability of less than 10(exp -10)/hr in flight-critical real time applications. The MAFT design objectives and architecture are presented. The fault-tolerance implementation of major functions in MAFT is also presented, including communication; task scheduling; reconfiguration; clock synchronization; and data handling and voting. The need for Byzantine agreement or approximate agreement in various functions is discussed. Different methods were selected to achieve agreement in various subsystems. These methods are illustrated by a more detailed description of the task scheduling and error handling subsystems. Author

**N91-17564*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
**DESIGN FOR VALIDATION, BASED ON FORMAL METHODS**
Ricky W. Butler *In its* NASA Formal Methods Workshop, 1990 Nov. 1990 19 p (For primary document see N91-17559

09-61)
Avail: NTIS HC/MF A22 CSCL 09B

Validation of ultra-reliable systems decomposes into two subproblems: (1) quantification of probability of system failure due to physical failure; (2) establishing that Design Errors are not present. Methods of design, testing, and analysis of ultra-reliable software are discussed. It is concluded that a design-for-validation based on formal methods is needed for the digital flight control systems problem, and also that formal methods will play a major role in the development of future high reliability digital systems. Y.S.

**N91-17565*#** SRI International Corp., Menlo Park, CA. Computer Science Lab.
**WHAT FM CAN OFFER DFCS DESIGN c08**
John Rushby *In* NASA, Langley Research Center, NASA Formal Methods Workshop, 1990 Nov. 1990 30 p (For primary document see N91-17559 09-61)
Avail: NTIS HC/MF A22 CSCL 09B

The results of aircrafts and spacecrafts flight tests are reported. It is shown that the problems of Digital Flight Control Systems (DFCS) are the problems of systems whose complexity has exceeded the reach of the intellectual tools employed. It is also shown that intuition, experience, and techniques derived from mechanical and analog systems are insufficient for complex, integrated, digital systems. Formal Methods (FM) of computer science can offer DFCS systematic techniques for the construction of trustworthy software, including: techniques for the precise specification of requirements and the development of designs; systematic approaches to the design and structuring of distributed and concurrent systems; fault tolerance algorithms; and systematic methods of testing and analytic methods of verification. Y.S.

**N91-17566*#** Computational Logic, Inc., Austin, TX.
**WHAT CAN FORMAL METHODS OFFER TO DIGITAL FLIGHT CONTROL SYSTEMS DESIGN c08**
Donald I. Good *In* NASA, Langley Research Center, NASA Formal Methods Workshop, 1990 Nov. 1990 38 p (For primary document see N91-17559 09-61)
Avail: NTIS HC/MF A22 CSCL 09B

Formal methods research begins to produce methods which will enable mathematic modeling of the physical behavior of digital hardware and software systems. The development of these methods directly supports the NASA mission of increasing the scope and effectiveness of flight system modeling capabilities. The conventional, continuous mathematics that is used extensively in modeling flight systems is not adequate for accurate modeling of digital systems. Therefore, the current practice of digital flight control system design has not had the benefits of extensive mathematical modeling which are common in other parts of flight system engineering. Formal methods research shows that by using discrete mathematics, very accurate modeling of digital systems is possible. These discrete modeling methods will bring the traditional benefits of modeling to digital hardware and hardware design. Sound reasoning about accurate mathematical models of flight control systems can be an important part of reducing risk of unsafe flight control. Author

**N91-17567*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
**HIGH LEVEL DESIGN PROOF OF A RELIABLE COMPUTING PLATFORM c60**
Ben L. DiVito, Ricky W. Butler, and James L. Caldwell *In its* NASA Formal Methods Workshop, 1990 Nov. 1990 28 p (For primary document see N91-17559 09-61)
Avail: NTIS HC/MF A22 CSCL 09B

The main objectives are: to establish hardware/software platform for ultra-reliable computing; to use fault tolerant computer architecture; to use formal methods to prevent design and implementation errors; and to construct reliability model to quantify reliability estimate. The results show that: ultra-reliable control systems are hard to achieve; simple fault tolerant design is postulated; formal specification of design is constructed; and preliminary correctness proofs are obtained. Y.S.

**N91-17568*#** SRI International Corp., Menlo Park, CA. Computer Science Lab.
**A VERIFIED MODEL OF FAULT-TOLERANCE**
John Rushby *In* NASA, Langley Research Center, NASA Formal Methods Workshop, 1990 Nov. 1990 20 p (For primary document see N91-17559 09-61)
Avail: NTIS HC/MF A22 CSCL 09B

The main objectives are: a model of a replicated system with exact-match voting; a fault model that includes transients; a theorem that establishes the conditions under which the system provides fault tolerance; a formal specification of the model; and a mechanically checked verification of the theorem that is consonant with the journal-level presentation. Formal specification and verification revealed typos in the original report, exposed omission in original proof, led to the stronger theorem and more elegant proof, and confirmed that Enhanced Hierarchical Development Methodology (EHDM) has the capability to specify interesting and useful properties in a direct, natural, and readable manner. Y.S.

**N91-17569*#** Computational Logic, Inc., Austin, TX.
**THE DESIGN AND PROOF OF CORRECTNESS OF A FAULT-TOLERANT CIRCUIT c33**
William R. Bevier and William D. Young *In* NASA, Langley Research Center, NASA Formal Methods Workshop, 1990 Nov. 1990 15 p (For primary document see N91-17559 09-61)
Avail: NTIS HC/MF A22 CSCL 09C

The flowing achievements are presented in view graph form: (1) a formal statement of interactive consistency conditions in the Boyer-Moore logic; (2) a formal statement of the oral messages (OM) algorithm in the Boyer-Moore logic; (3) a mechanically checked proof that OM satisfies the interactive consistency conditions; (4) a mechanically checked proof of the optimality result--no algorithm can tolerate fewer faults than OM yet still achieve interactive consistency; (5) the use of OM in a functional specification for a fault-tolerant device; (6) a formal description of the design of the device; (7) a mechanically checked proof that the device design satisfies the specification; and (8) an implementation of the design in programmable logic arrays. K.S.

**N91-17570*#** Odyssey Research Associates, Inc., Ithaca, NY.
**VERIFYING AN INTERACTIVE CONSISTENCY CIRCUIT: A CASE STUDY IN THE REUSE OF A VERIFICATION TECHNOLOGY**
Mark Bickford and Mandayam Srivas *In* NASA, Langley Research Center, NASA Formal Methods Workshop, 1990 Nov. 1990 31 p (For primary document see N91-17559 09-61)
Avail: NTIS HC/MF A22 CSCL 09B

The work done at ORA for NASA-LRC in the design and formal verification of a hardware implementation of a scheme for attaining interactive consistency (byzantine agreement) among four microprocessors is presented in view graph form. The microprocessors used in the design are an updated version of a formally verified 32-bit, instruction-pipelined, RISC processor, MiniCayuga. The 4-processor system, which is designed under the assumption that the clocks of all the processors are synchronized, provides software control over the interactive consistency operation. Interactive consistency computation is supported as an explicit instruction on each of the microprocessors. An identical user program executing on each of the processors decides when and on what data interactive consistency must be performed. This exercise also served as a case study to investigate the effectiveness of reusing the technology which was developed during the MiniCayuga effort for verifying synchronous hardware designs. MiniCayuga was verified using the verification system Clio which was also developed at ORA. To assist in reusing this technology, a computer-aided specification and verification tool was developed. This tool specializes Clio to synchronous hardware designs and significantly reduces the tedium involved in verifying

such designs. The tool is presented and how it was used to specify and verify the interactive consistency circuit is described.
Author

**N91-17571*#** Computational Logic, Inc., Austin, TX.
**HARDWARE VERIFICATION AT COMPUTATIONAL LOGIC, INC.**
Bishop C. Brock and Warren A. Hunt, Jr. *In* NASA, Langley Research Center, NASA Formal Methods Workshop, 1990 Nov. 1990 22 p (For primary document see N91-17559 09-61)
Avail: NTIS HC/MF A22 CSCL 09B

The following topics are covered in viewgraph form: (1) hardware verification; (2) Boyer-Moore logic; (3) core RISC; (4) the FM8502 fabrication, implementation specification, and pinout; (5) hardware description language; (6) arithmetic logic generator; (7) near term expected results; (8) present trends; (9) future directions; (10) collaborations and technology transfer; and (11) technology enablers.
K.S.

**N91-17572*#** Idaho Univ., Moscow. Dept. of Computer Science.
**GENERIC INTERPRETERS AND MICROPROCESSOR VERIFICATION** **c60**
Phillip J. Windley *In* NASA, Langley Research Center, NASA Formal Methods Workshop, 1990 Nov. 1990 33 p (For primary document see N91-17559 09-61)
(Contract NAS1-18586)
Avail: NTIS HC/MF A22 CSCL 09B

The following topics are covered in viewgraph form: (1) generic interpreters; (2) Viper microprocessors; (3) microprocessor verification; (4) determining correctness; (5) hierarchical decomposition; (6) interpreter theory; (7) AVM-1; (8) phase-level specification; and future work.
K.S.

**N91-17573*#** Royal Signals and Radar Establishment, Malvern (England).
**VIPER PROJECT** **c60**
John Kershaw *In* NASA, Langley Research Center, NASA Formal Methods Workshop, 1990 Nov. 1990 24 p (For primary document see N91-17559 09-61)
Avail: NTIS HC/MF A22 CSCL 09B

The VIPER project has so far produced a formal specification of a 32 bit RISC microprocessor, an implementation of that chip in radiation-hard SOS technology, a partial proof of correctness of the implementation which is still being extended, and a large body of supporting software. The time has now come to consider what has been achieved and what directions should be pursued in the future. The most obvious lesson from the VIPER project was the time and effort needed to use formal methods properly. Most of the problems arose in the interfaces between different formalisms, e.g., between the (informal) English description and the HOL spec, between the block-level spec in HOL and the equivalent in ELLA needed by the low-level CAD tools. These interfaces need to be made rigorous or (better) eliminated. VIPER 1A (the latest chip) is designed to operate in pairs, to give protection against breakdowns in service as well as design faults. We have come to regard redundancy and formal design methods as complementary, the one to guard against normal component failures and the other to provide insurance against the risk of the common-cause failures which bedevil reliability predictions. Any future VIPER chips will certainly need improved performance to keep up with increasingly demanding applications. We have a prototype design (not yet specified formally) which includes 32 and 64 bit multiply, instruction pre-fetch, more efficient interface timing, and a new instruction to allow a quick response to peripheral requests. Work is under way to specify this device in MIRANDA, and then to refine the spec into a block-level design by top-down transformations. When the refinement is complete, a relatively simple proof checker should be able to demonstrate its correctness. This paper is presented in viewgraph form.
Author

**N91-17574*#** SRI International Corp., Menlo Park, CA. Computer Science Lab.
**MECHANICAL PROOFS OF FAULT-TOLERANT CLOCK SYNCHRONIZATION** **c60**
N. Shankar *In* NASA, Langley Research Center, NASA Formal Methods Workshop, 1990 Nov. 1990 37 p (For primary document see N91-17559 09-61)
Avail: NTIS HC/MF A22 CSCL 09B

The following topics are covered in viewgraph form: (1) introduction to clock synchronization protocols; (2) a schematic formulation of clock synchronization; (3) the interactive convergence algorithm; (4) verification of Schneider's formulation; (5) verification of interactive convergence; (6) a hardware-oriented clock synchronization protocol; (7) verification of Infis/Moore's protocol; and (8) the EHDM specification/verification environment.
K.S.

**N91-17575*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
**A HOL THEORY FOR VOTING**
Paul S. Miner and James L. Caldwell *In its* NASA Formal Methods Workshop, 1990 Nov. 1990 15 p (For primary document see N91-17559 09-61)
Avail: NTIS HC/MF A22 CSCL 09B

Central to fault-tolerant computing is redundancy management, and common to proofs of fault-tolerance is a maximum fault assumption. Typically a maximum fault assumption is rather restrictive. Usually, this is necessary to avoid assumptions about the behavior of faulty channels. A maximum fault assumption is useful because it allows reasoning about fault tolerance in the presence of arbitrarily malicious fault behavior. However, analysis of the architecture may establish certain scenarios in which the assumption may be weakened. Proofs comparing majority and plurality and proofs of simple reconfiguration strategies are presented in viewgraph form.
K.S.

**N91-17576*#** Odyssey Research Associates, Inc., Ithaca, NY.
**FORMALLY SPECIFYING THE LOGIC OF AN AUTOMATIC GUIDANCE CONTROLLER**
David Guaspari *In* NASA, Langley Research Center, NASA Formal Methods Workshop, 1990 Nov. 1990 20 p (For primary document see N91-17559 09-61)
Avail: NTIS HC/MF A22 CSCL 09B

The following topics are covered in viewgraph form: (1) the Penelope Project; (2) the logic of an experimental automatic guidance control system for a 737; (3) Larch/Ada specification; (4) some failures of informal description; (5) description of mode changes caused by switches; (6) intuitive description of window status (chosen vs. current); (7) design of the code; (8) and specifying the code.
K.S.

**N91-17577*#** Odyssey Research Associates, Inc., Ithaca, NY.
**VERIFICATION OF FLOATING-POINT SOFTWARE**
Doug N. Hoover *In* NASA, Langley Research Center, NASA Formal Methods Workshop, 1990 Nov. 1990 18 p (For primary document see N91-17559 09-61)
Avail: NTIS HC/MF A22 CSCL 09B

Floating point computation presents a number of problems for formal verification. Should one treat the actual details of floating point operations, or accept them as imprecisely defined, or should one ignore round-off error altogether and behave as if floating point operations are perfectly accurate. There is the further problem that a numerical algorithm usually only approximately computes some mathematical function, and we often do not know just how good the approximation is, even in the absence of round-off error. ORA has developed a theory of asymptotic correctness which allows one to verify floating point software with a minimum entanglement in these problems. This theory and its implementation in the Ariel C verification system are described. The theory is illustrated using a simple program which finds a zero of a given function by bisection. This paper is presented in viewgraph form.
Author

**N91-17578*#** Odyssey Research Associates, Inc., Ithaca, NY.
**C FORMAL VERIFICATION WITH UNIX COMMUNICATION AND CONCURRENCY**
Doug N. Hoover *In* NASA, Langley Research Center, NASA Formal Methods Workshop, 1990 Nov. 1990 14 p (For primary document see N91-17559 09-61)
Avail: NTIS HC/MF A22 CSCL 09B

The results of a NASA SBIR project are presented in which CSP-Ariel, a verification system for C programs which use Unix system calls for concurrent programming, interprocess communication, and file input and output, was developed. This project builds on ORA's Ariel C verification system by using the system of Hoare's book, Communicating Sequential Processes, to model concurrency and communication. The system runs in ORA's Clio theorem proving environment. The use of CSP to model Unix concurrency and sketch the CSP semantics of a simple concurrent program is outlined. Plans for further development of CSP-Ariel are discussed. This paper is presented in viewgraph form.
Author

**N91-17579*#** Wisconsin Univ., Madison. Space Science and Engineering Center.
**MANAGEMENT AND DISPLAY OF FOUR-DIMENSIONAL ENVIRONMENTAL DATA SETS USING McIDAS Final Report, 28 Feb. 1986 - 31 Aug. 1990**
William L. Hibbard, David Santek, and Verner E. Suomi Nov. 1990 126 p
(Contract NAS8-36292)
(NASA-CR-184081; NAS 1.26:184081) Avail: NTIS HC/MF A07 CSCL 09B

Over the past four years, great strides have been made in the areas of data management and display of 4-D meteorological data sets. A survey was conducted of available and planned 4-D meteorological data sources. The data types were evaluated for their impact on the data management and display system. The requirements were analyzed for data base management generated by the 4-D data display system. The suitability of the existing data base management procedures and file structure were evaluated in light of the new requirements. Where needed, new data base management tools and file procedures were designed and implemented. The quality of the basic 4-D data sets was assured. The interpolation and extrapolation techniques of the 4-D data were investigated. The 4-D data from various sources were combined to make a uniform and consistent data set for display purposes. Data display software was designed to create abstract line graphic 3-D displays. Realistic shaded 3-D displays were created. Animation routines for these displays were developed in order to produce a dynamic 4-D presentation. A prototype dynamic color stereo workstation was implemented. A computer functional design specification was produced based on interactive studies and user feedback.
B.G.

**N91-17580#** Royal Signals and Radar Establishment, Malvern (England).
**THE QR-DECOMPOSITION BASED LEAST-SQUARES LATTICE ALGORITHM FOR ADAPTIVE FILTERING**
I. K. Proudler and J. G. McWhirter Jul. 1990 64 p
(RSRE-MEMO-4409; BR115234; ETN-91-98415) Copyright
Avail: NTIS HC/MF A04

The least squares lattice algorithm for adaptive filtering based on the QR Decomposition (QRD) is derived from first principles. In common with other lattice algorithms for adaptive filtering, this algorithm only requires O(p) operations for the solution of a p-th order problem. The algorithm has as its root the QRD based recursive least squares minimization algorithm and hence is expected to have superior numerical properties when compared with other fast algorithms. This algorithm contains within it the QRD based algorithm for solving the least squares linear prediction problem. These algorithms are presented in two forms: one that involves taking square roots and one does not. Some computer simulations of a channel equalizer, using finite precision arithmetic, are presented in which the lattice algorithms are compared to the more established triangular systolic array ones. The relationship between the QRD based lattice algorithm and other least squares lattice algorithms is discussed. Various extensions to this work are discussed including the multichannel QRD based adaptive filtering algorithm that can be used for wide band beamforming.
ESA

**N91-17581*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
**PROCEEDINGS OF THE 14TH ANNUAL SOFTWARE ENGINEERING WORKSHOP**
29 Nov. 1989 375 p Workshop held in Greenbelt, MD, 29 Nov. 1989
(NASA-TM-103389; NAS 1.15:103389; SEL-89-007) Avail: NTIS HC/MF A16 CSCL 09B

Several software related topics are presented. Topics covered include studies and experiment at the Software Engineering Laboratory at the Goddard Space Flight Center, predicting project success from the Software Project Management Process, software environments, testing in a reuse environment, domain directed reuse, and classification tree analysis using the Amadeus measurement and empirical analysis.
Author

**N91-17582*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
**PROCEEDINGS OF THE 2ND NASA Ada USER'S SYMPOSIUM**
Nov. 1989 309 p Symposium held in Greenbelt, MD, 30 Nov. 1989
(NASA-TM-103407; NAS 1.15:103407; SEL-89-008) Avail: NTIS HC/MF A14 CSCL 09B

Several presentations, mostly in viewgraph form, on various topics relating to Ada applications are given. Topics covered include the use of Ada in NASA, Ada and the Space Station, the software support environment, Ada in the Software Engineering Laboratory, Ada at the Jet Propulsion Laboratory, the Flight Telerobotic Servicer, and lessons learned in prototyping the Space Station Remote Manipulator System control.
Author

**N91-17583*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
**DATABASE ACCESS MANAGER FOR THE SOFTWARE ENGINEERING LABORATORY (DAMSEL) USER'S GUIDE**
Mar. 1990 334 p
(NASA-TM-103392; SEL-90-001; NAS 1.15:103392) Avail: NTIS HC/MF A15 CSCL 09B

Operating instructions for the Database Access Manager for the Software Engineering Laboratory (DAMSEL) system are presented. Step-by-step instructions for performing various data entry and report generation activities are included. Sample sessions showing the user interface display screens are also included. Instructions for generating reports are accompanied by sample outputs for each of the reports. The document groups the available software functions by the classes of users that may access them.
Author

**N91-17584*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
**THE CLEANROOM CASE STUDY IN THE SOFTWARE ENGINEERING LABORATORY: PROJECT DESCRIPTION AND EARLY ANALYSIS**
Scott Green, Ara Kouchakdjian, Victor Basili (Maryland Univ., College Park.), and David Weidow Mar. 1990 51 p
(NASA-TM-103390; NAS 1.15:103390; SEL-90-002) Avail: NTIS HC/MF A04 CSCL 09B

This case study analyzes the application of the cleanroom software development methodology to the development of production software at the NASA/Goddard Space Flight Center. The cleanroom methodology emphasizes human discipline in program verification to produce reliable software products that are right the first time. Preliminary analysis of the cleanroom case study shows that the method can be applied successfully in the FDD environment and may increase staff productivity and product quality. Compared to typical Software Engineering Laboratory (SEL) activities, there is evidence of lower failure rates, a more complete

and consistent set of inline code documentation, a different distribution of phase effort activity, and a different growth profile in terms of lines of code developed. The major goals of the study were to: (1) assess the process used in the SEL cleanroom model with respect to team structure, team activities, and effort distribution; (2) analyze the products of the SEL cleanroom model and determine the impact on measures of interest, including reliability, productivity, overall life-cycle cost, and software quality; and (3) analyze the residual products in the application of the SEL cleanroom model, such as fault distribution, error characteristics, system growth, and computer usage. K.S.

**N91-17585*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
**COLLECTED SOFTWARE ENGINEERING PAPERS, VOLUME 8**
Nov. 1990 121 p
(NASA-TM-103393; SEL-90-005; NAS 1.15:103393) Avail: NTIS HC/MF A06 CSCL 09B

A collection of selected technical papers produced by participants in the Software Engineering Laboratory (SEL) during the period November 1989 through October 1990 is presented. The purpose of the document is to make available, in one reference, some results of SEL research that originally appeared in a number of different forums. Although these papers cover several topics related to software engineering, they do not encompass the entire scope of SEL activities and interests. Additional information about the SEL and its research efforts may be obtained from the sources listed in the bibliography. The seven presented papers are grouped into four major categories: (1) experimental research and evaluation of software measurement; (2) studies on models for software reuse; (3) a software tool evaluation; and (4) Ada technology and studies in the areas of reuse and specification. Author

**N91-17586#** Pratt and Whitney Aircraft, West Palm Beach, FL. Government Products Div.
**GEOMETRIC MODELING APPLICATIONS INTERFACE PROGRAM, VOLUME 3 Final Report, 1 Aug. 1985 - 31 Mar. 1989**
R. Disa, C. VanWie, K. Arnold, J. Altemueller, and A. Whelan Nov. 1990 360 p
(Contract F33615-85-C-5122)
(AD-A228061; FR20889; WRDC-TR-90-8027-VOL-3) Avail: NTIS HC/MF A16 CSCL 12/5

This As-Built Product Specification establishes the as-built Computer Program Configuration Item (CPCI) identified as the GMAP/PDDI System Components under U.S. Air Force Contract F33615-85-C-5122. It includes descriptions of the structure, functions, language, database requirements, interfaces, and quality assurance provisions of the primary GMAP system components: the System Translator, Model Access Software with Name/Value Interface, and the Schema Manager. GRA

**N91-17587#** Institute for Defense Analyses, Alexandria, VA.
**IMPROVING METHODS FOR ESTIMATING SOFTWARE DEVELOPMENT COSTS Final Report, Jun. 1989 - Jun. 1990**
Steven R. Shyman and T. Keith Blankenship Jun. 1990 42 p
(Contract MDA903-89-C-0003)
(AD-A228385; AD-E501277; IDA-P-2388; IDA/HQ-90-35427)
Avail: NTIS HC/MF A03 CSCL 12/5

Two methods for deriving more accurate estimates of software development costs are explored. The first method involves the use of a simple cost estimating relationship in which the single input of size (in lines of code) is used. The second method involves multiple inputs used in the Constructive Cost Model (COCOMO). GRA

**N91-17588#** IBM Federal Systems Div., Gaithersburg, MD.
**STARS REUSABILITY GUIDELINES Final Report**
R. H. Ekman 30 Apr. 1990 58 p
(Contract F19628-88-D-0032)
(AD-A228468) Avail: NTIS HC/MF A04 CSCL 12/5

A guide to software reuse using the STARS (Software Technology for Adaptable Reliable Systems) Repository is presented. The IBM Stars Repository Guidebook, STARS Repository User's Guide, and STARS Reusability Guidelines are each described. IBM STARS Repository Guidebook: A guide to the STARS Repository, providing high-level information for all users (component reusers, component suppliers, and repository administrators). The Guidebook is organized according to the specific roles that users perform when using the system. STARS Repository User's Guide: A guide on how to access and use the STARS Repository. It provides the basic information needed to use the repository software, but it is not a comprehensive guide to the VAX computer, on which the repository is built. STARS Reusability Guidelines: A set of Ada coding guidelines for component development that emphasize reusability. Code that follows these guideline will be easier to reuse on multiple projects and platforms. Many examples are provided illustrating the guidelines. GRA

**N91-17589#** Science Applications International Corp., Clearwater, FL.
**IBM STARS REPOSITORY USER'S GUIDE Final Report**
R. H. Ekman 10 May 1990 48 p
(Contract F19628-88-D-0032)
(AD-A228469; CDRL-1550) Avail: NTIS HC/MF A03 CSCL 12/5

A guide to software reuse using the STARS (Software Technology for Adaptable Reliable Systems) Repository is discussed. The IBM STARS Repository Guidebook, STARS Repository User's Guide, and STARS Reusability Guidelines is each described. IBM STARS Repository Guidebook: A guide to the STARS Repository, providing high level information for all users (component reusers, component suppliers, and repository administrator). The Guidebook is organized according to the specific roles that users perform when using the system. STARS Repository User's Guide: A guide on how to access and use the STARS Repository. It provides the basic information needed to use the Repository software, but it is not a comprehensive guide to the VAX computer, on which the Repository is built. STARS Reusability Guidelines: A set of Ada coding guidelines for component development that emphasize reusability. Code that follows these guidelines will be easier to reuse on multiple projects and platforms. Many examples are provided illustrating the guidelines. GRA

**N91-17590#** International Business Machines Corp., Gaithersburg, MD. Systems Integration Div.
**IBM STARS REPOSITORY GUIDEBOOK Final Report**
R. H. Ekman 30 Apr. 1990 73 p
(Contract F19628-88-D-0032)
(AD-A228470; CDRL-1550) Avail: NTIS HC/MF A04 CSCL 12/5

This guidebook provides high level information for all users of the IBM STARS (Software Technology for Adaptable Reliable Systems) Repository. It describes how to use the Repository system in the context of software reuse. The Guidebook is organized according to specific roles that users perform when using the system. It addresses the information needs of component reusers, component suppliers, and repository administrators. This Guidebook defines: (1) How to use the IBM STARS Repository; (2) Resources and capabilities of the Repository; (3) Component standards for admission to and promotion within the Repository; (4) Procedures for submission and usage of repository components; (5) Processes involved in managing repository assets; and (6) The reuse process in the context of the STARS repository. GRA

**N91-17591#** IBM Federal Systems Div., Gaithersburg, MD.
**UPDATED APPLICATION BLUEPRINT DEFINITION FOR C3 FOR THE SOFTWARE TECHNOLOGY FOR ADAPTABLE, RELIABLE SYSTEMS (STARS) PROGRAM Final Report**
J. Piotrowski 30 Jun. 1990 58 p
(Contract F19628-88-D-0032)
(AD-A228471; CDRL-1490A-001) Avail: NTIS HC/MF A04 CSCL 12/5

Application blueprints serve as frameworks for designing new systems in an application domain, leading to reuse of design

information and greater reuse of code. The term application blueprint is defined, its creation is described, and the benefits and drawbacks of this approach is this discussed. The appendix presents a generic specification and information about the initial domain analysis for creating an application blueprint for an air traffic control system. Future research on reusing analysis and design information may be based on this research. GRA

**N91-17592#** International Business Machines Corp., Gaithersburg, MD. Systems Integration Div.
**REPOSITORY OPERATIONS AND PROCEDURES FOR THE SOFTWARE TECHNOLOGY FOR ADAPTABLE, RELIABLE SYSTEMS (STARS) PROGRAM Final Report**
T. Ward 7 Mar. 1990 54 p
(Contract F19628-88-D-0032)
(AD-A228472; CDRL-1470) Avail: NTIS HC/MF A04 CSCL 12/5

A set of repository policies and procedures are presented which are based on the operational experience with the current STARS Repository Prototype. They must be expanded with additional operational experience and approved prior to the general availability of the STARS Repository to the public sector or specific subsets of the public sector, e.g., any current Government contractor. The recommended repository policies and operating procedures have to evolve as experience is gained from actual operation of the repository. This is particulary true when guidelines, standards, scope of content, and the use of the repository is open to additional user classes, e.g., other DoD projects, Government agencies, and private industry. Several issues that must be constantly reviewed, e.g., cost of operation, repository staff responsibilities, limited data rights, and risks involved with the repository operation and component reuse. GRA

**N91-17593#** International Business Machines Corp., Gaithersburg, MD. Systems Integration Div.
**REPOSITORY GUIDEBOOK FOR THE SOFTWARE TECHNOLOGY FOR ADAPTABLE, RELIABLE SYSTEMS (STARS) PROGRAM Final Technical Report**
R. H. Ekman 30 Apr. 1990 47 p Revised
(Contract F19628-88-D-0032)
(AD-A228474; CDRL-1550) Avail: NTIS HC/MF A03 CSCL 12/5

A guide is presented to software reuse using the STARS Respiratory. The IBM STARS Repository Guidebook, STARS Repository User's Guide, and STARS Reusability Guidelines are each described. IBM STARS Repository Guidebook: A guide to the STARS Repository, providing high level information for all users (component reusers, component suppliers, and repository administrators). The Guidebook is organized according to the specific roles that users perform when using the system. STARS Repository User's Guide: A guide on how to access and use the STARS Repository. It provides the basic information needed to use the repository software, but it is not a comprehensive guide to the VAX computer, on which the respiratory is built. STARS Reusability Guidelines: A set of Ada coding guidelines for component development that emphasize reusability. Code that follows these guidelines will be easier to reuse on multiple projects and platform. Many examples are provided illustrating the guidelines. GRA

**N91-17594#** IBM Federal Systems Center, Gaithersburg, MD.
**SGML PRODUCT REVIEW FOR THE SOFTWARE TECHNOLOGY FOR ADAPTABLE, RELIABLE SYSTEMS (STARS) PROGRAM Final Report**
S. Kutoroff 1 Jul. 1990 39 p
(Contract F19628-88-D-0032)
(AD-A228476) Avail: NTIS HC/MF A03 CSCL 12/5

This document details the software products currently available for creating and processing documents using the Standard Generalized Markup Language (SGML) as specified in ISO 8879:1986 and in MIL-STD-28001A (CALS). SGML products range from complete systems (which do everything from allowing a user to create a document to printing a formatted document) to smaller products which are used for only one or two specific functions in the SGML document processing model. SGML document processing involves the following functions: (1) creating a Document Type Declaration (DTD); (2) parsing a DTD; (3) creating a Document Instance (document marked-up in SGML based on DTD); (4) parsing a Document Instance; and (5) translating the SGML in a Document Instance into a formatting language for output. The advantage of using a product which performs only a few of these functions lies in the price and in the ability to customize the products to the user's needs. This section will describe SGML product types and the function each performs in producing a SGML document. GRA

**N91-17595#** IBM Federal Systems Center, Gaithersburg, MD.
**INFORMATION OBJECT MODELING METHODOLOGY FOR THE SOFTWARE TECHNOLOGY FOR ADAPTABLE, RELIABLE SYSTEMS (STARS) PROGRAM Final Report**
William H. Ett 21 Jun. 1990 146 p
(Contract F19628-88-D-0032)
(AD-A228477) Avail: NTIS HC/MF A07 CSCL 12/5

Information Object Modeling is a technique for developing specification models for systems. The techniques for building Information Object Models were adapted from techniques of real-time structured analysis and the Foxboro company's experience in specifying and developing real-time process control systems. An Information Object Model (IOM) is organized to provide levels of information for different audiences, so that one document can meet the needs of different people. A mission statement describes the scope of the system. An overview of the system describes the major functional objects. Finally, each functional object is discussed in detail. The modeling techniques for an IOM use the graphical techniques of real-time structured analysis, including transformation diagrams (data flow plus control flow), state transition diagrams, and entity relationship diagrams. Transformation diagrams, however, are applied in a different manner, representing the communication of objects organized hierarchically rather than a functional decomposition of processes. This report introduces the IOM methodology, explains what an Information Object Model is, and provides guidance on developing and reviewing diagrams as part of such models. The report also discusses the brief, yet intense history of a government-run experiment using the Information Object Modeling methodology. GRA

**N91-17596#** IBM Federal Systems Center, Gaithersburg, MD.
**SGML LESSONS LEARNED FOR THE SOFTWARE TECHNOLOGY FOR ADAPTABLE, RELIABLE SYSTEMS (STARS) PROGRAM Final Report**
S. Kutoroff 12 Jul. 1990 20 p
(Contract F19628-88-D-0032)
(AD-A228478) Avail: NTIS HC/MF A03 CSCL 12/5

SGML (Standard Generalized Markup Language) is an international standard for representing the elements and structure of electronically stored text. SGML uses Document Type Definitions (DTD's) to unify the structure of various kinds of documents. This document summarizes the experience of building a new DTD and discusses the lessons learned in the performance of this task as well as describe the options available to SGML users and the impact of SGML on STARS contractors and subcontractors. Recommendations will be made on SGML products for subcontractors to use in document preparation as well as on support issues within the STARS program SGML software products fall into several categories (examples are in parenthesis): (1) DTD based SGML editors (XGML Check Mark, Text Write, Author/Editor); (2) parsers (XGML Validator, Parse Station); (3) formatting systems (DL Pager, Soft Quad Publishing System); (4) SGML Publishing Systems (Compugraphic's Automated Publishing System); and (5) conversion products (Fast Tag, XGML Translator). GRA

**N91-17597#** IBM Federal Systems Center, Gaithersburg, MD.
**STARS STRUCTURE (DOD AAS IOM DOCUMENT VERSION 1.3) FOR THE SOFTWARE TECHNOLOGY FOR ADAPTABLE, RELIABLE SYSTEMS (STARS) PROGRAM Final Report**
William H. Ett 11 May 1990 284 p
(Contract F19628-88-D-0032)
(AD-A228479) Avail: NTIS HC/MF A13 CSCL 12/7

Information Object Modeling is a technique for developing specification models for systems. The techniques for building Information Object Models were adapted from techniques of real-time structured analysis and the Foxboro company's experience in specifying and developing real-time process control systems. An information object Model (IOM) is organized to provide levels of information for different audiences, so that one document can meet the needs of different people. A mission statement is provided which describes the scope of the system. An overview of the system describes the major functional objects. Finally, each functional object is discussed in detail. The modeling techniques for an IOM use the graphical techniques real-time structured analysis, including transformation diagrams (data flow plus control flow), state transition diagrams, and entity relationship diagrams. Transformation diagrams, however, are applied in a different manner, representing the communication of objects organized hierarchically rather than a functional decomposition of processes. This document describes a specification model for an air traffic control system prepared using Real Time Structured Analysis. It shows Foxboro's concept of specification packaging and can serve as an alternative to MIL-STD-2167A. GRA

**N91-17598#** IBM Federal Systems Center, Gaithersburg, MD.
**USER'S MANUAL FOR A PROTOTYPE BINDING OF ANSI-STANDARD SQL TO Ada SUPPORTING THE SAME METHODOLOGY FOR THE SOFTWARE TECHNOLOGY FOR ADAPTABLE, RELIABLE SYSTEMS (STARS) PROGRAM Final Report**
S. Phillips 30 Jun. 1990 146 p Prepared in cooperation with Lockheed Missiles and Space Co., Austin, TX
(Contract F19628-88-D-0032)
(AD-A228480) Avail: NTIS HC/MF A07 CSCL 12/5

A standard binding was needed between Ada and SQL (Structured Query Language), the ANSI and DoD standard for accessing commercial relational data base management systems (DBMS's). SQL was not designed to be embedded within applications in general purpose programming languages, such as Ada. Previously developed Ada-SQL bindings have had various technical drawbacks. A prototype (Ada-SQL binding was built by automating the SQL Ada Module Extension methodology (SAME). SAME is a method for building Ada applications that access DBMS's via SQL. SAME extends SQL by exploiting the features of Ada. This User's Manual contains installation instructions, compilation order, guidelines for input data, detailed steps to create a specific binding, and information about porting the system to another DBMS. GRA

**N91-17599#** IBM Federal Systems Center, Gaithersburg, MD.
**GENERAL DEFINITION OF PROJECT (Ada/SQL BINDING) FOR THE SOFTWARE TECHNOLOGY FOR ADAPTABLE, RELIABLE SYSTEMS (STARS) Final Report**
S. Phillips 31 Dec. 1989 22 p
(Contract F19628-88-D-0032)
(AD-A228481) Avail: NTIS HC/MF A03 CSCL 12/5

A standard binding was needed between Ada and SQL (Structured Query Language), the ANSI and DoD standard for accessing commercial relational data base management systems (DBMS's). SQL was not designed to be embedded within applications in general purpose programming languages, such as Ada. Previously developed Ada-SQL bindings have had various technical drawbacks. A prototype Ada-SQL binding was built by automating the SQL Ada Module Extension methodology (SAME). SAME is a method for building Ada applications that access DBMS's via SQL. SAME extends SQL by exploiting the features of Ada. This Technical Plan presents the background, technical approach, and top-level capabilities of the project. It also discusses such technical problems as storing arbitrary data types in a data base and using SAME without a module language compiler. GRA

**N91-17600#** IBM Federal Systems Center, Gaithersburg, MD.
**SOFTWARE-FIRST LIFE CYCLE FINAL DEFINITION FOR THE SOFTWARE TECHNOLOGY FOR ADAPTABLE, RELIABLE SYSTEMS (STARS) Final Report**
Maurice Blumberg and Mary Catherine Ward 15 Jan. 1990 91 p
(Contract F19628-88-D-0032)
(AD-A228483) Avail: NTIS HC/MF A05 CSCL 12/5

This document, IBM Contract Data Requirements List (CDRL) Sequence Number 1240, describes the final definition of a Software-First Life Cycle (SFLC), developed under the Q and R increments of the STARS (Software Technology for Adaptable Reliable Systems) program. The SFLC provides a dramatically different approach to systems development by integrating the use of rapid prototyping, reusable components, concurrent engineering, and other new and emerging technologies. This approach, which takes advantage of the benefits of each of the included technologies, has the potential for a substantial improvement in productivity, while increasing the quality and reusability of the developed system. The SFLC consists of 5 phases: Preliminary System Analysis, System Architecture, Software Growing, Productization and Production, and System Operation and Support. Each of these phases are formally defined using the ETVX (Entry Criteria, Task, Validation, and Exit Criteria) model. The major input, output and intermediate work products are also identified and defined. GRA

**N91-17601#** IBM Federal Systems Center, Gaithersburg, MD.
**SAMPLE TAILORING OF 2167A DIDS FOR SOFTWARE-FIRST LIFE CYCLE Final Report**
Maurice Blumberg 14 Aug. 1990 130 p
(Contract F19628-88-D-0032)
(AD-A228487) Avail: NTIS HC/MF A07 CSCL 12/5

The DoD-STD-2167A military standard provides a framework of activities, work products, reviews, etc. which can be tailored by contractors to the specific requirements of a project. The STARS program began this tailoring process by developing section-by-section guidelines for tailoring data item description (DID) sections of DoD-STD-2167A CDRL items for use as Software-First Life Cycle (SFLC) CDRL items. This was possible since there is a one-to-one mapping between DoD-STD-2167A deliverable items and SFLC deliverable items. The SFLC provides a dramatically different approach to systems development by integrating the use of rapid prototyping, software use, concurrent engineering, and other emerging technologies. This document contains a description of a proposed set of deliverable items which will support the SFLC, a mapping of DoD-STD-2167A deliverable items to be proposed SFLC deliverable items, and tailoring guidelines on a section-by-section basis for DoD-STD-2167A deliverable items. GRA

**N91-17602#** Cornell Univ., Ithaca, NY. School of Electrical Engineering.
**PARALLEL ALGORITHMS FOR REAL TIME SIGNAL PROCESSING Final Report, 1 Jul. 1986 - 30 Jun. 1990**
Franklin Luk 1990 3 p
(Contract DAAL03-86-G-0016)
(AD-A228592; ARO-23776.1-MA-F) Avail: NTIS HC/MF A01 CSCL 09/1

A study was made of the emerging research area of algorithmic fault tolerance. This topic is attracting lots of attention due to its low implementation overhead and to its suitability for very large scale integration multiprocessor arrays. A fundamental contribution was made in the area by providing a novel linear algebraic model for the technique. In addition, a new fault tolerance scheme was developed for recursive least squares minimization. Other results include new ways for generating weights for the checksum method. GRA

**N91-17603#** Massachusetts Inst. of Tech., Cambridge. Artificial Intelligence Lab.
**DATAFLOW COMPUTATION FOR THE J-MACHINE**
Ellen Spertus Jun. 1990 140 p
(Contracts N00014-87-K-0825; N00014-88-K-0738; N00014-85-K-0124)
(AD-A228612; AI-TR-1233) Avail: NTIS HC/MF A07 CSCL 12/5

The dataflow model of computation exposes and exploits parallelism in programs without requiring programmer annotation; however, instruction-level dataflow is too fine-grained to be efficient on general-purpose processors. A popular solution is to develop a hybrid model of computation where regions of dataflow graphs are combined into sequential blocks of code. Such a system was implemented to allow the J-Machine to run Id programs, leaving exposed a high amount of parallelism - such as among loop iterations. This system is described and an analysis provided of its strengths and weakness and those of the J-Machine, along with ideas for improvement. GRA

**N91-17604#** Transportation Research Board, Washington, DC.
**COMPUTER-AIDED DESIGN AND DRAFTING SYSTEMS Final Report**
Aug. 1990 35 p Sponsored in part by Federal Highway Administration; and American Association of State Highway and Transportation Officials
(PB90-262254; TRB/NCHRP/SYN-161; ISBN-0-309-04906-7; LC-90-70619) Avail: NTIS HC/MF A03 CSCL 09B

The use of computer aided design and drafting (CADD) for highway design by the states' (U.S. and Canadian) departments of transportation (DOT) is discussed. DOTs have made major investments in money, labor, and organizational energy to implement CADD technology. About half of the design drafting work accomplished at DOTs using CADD is being done on those systems. Moreover, DOTs indicate that CADD has given those using CADD substantial productivity increases over manual design and drafting procedures. These productivity increases were more than sufficient to offset the operating costs of the CADD systems. Thus, there was a net savings in the cost of drafting functions as a result of using CADD. GRA

**N91-17605#** Massachusetts Inst. of Tech., Cambridge. Artificial Intelligence Lab.
**CONCURRENT AGGREGATES (CA): A OBJECT-ORIENTED LANGUAGE FOR FINE-GRAINED MESSAGE-PASSING MACHINES**
Andrew Andai Chien Jul. 1990 168 p
(Contracts N00014-88-K-0738; N00014-87-K-0825)
(AD-A228712; AI-TR-1248) Avail: NTIS HC/MF A08 CSCL 12/5

Fine-grained parallel machines exhibit great potential for high speed computation. Several machines such as the J-machine and the Mosaic C are projected to provide peak performance of 100's of billions of instructions per second in an air-cooled computer that fits in a cubic meter. While the hardware technology to build fine-grained machines is available, significant challenges remain in developing software systems to harness their computational power. To program massively-concurrent MIMD machines, programmers need tools for managing complexity. One important tool used in the sequential programming world is hierarchies of abstractions. Unfortunately, most concurrent object-oriented languages construct hierarchical abstractions from objects that serialize - serializing the abstractions. In machines with tens of thousands of processors, this unnecessary serialization can cause significant loss of concurrency. Tools for managing concurrency should not restrict or reduce program concurrency. Concurrent Aggregated (CA) provides multiple-access data abstraction tools, Aggregates, for managing program complexity. These tools can be used to implement abstractions with virtually unlimited potential for concurrency. Such tools allow programmers to modularize programs without reducing concurrency. These aggregates can be composed hierarchies of abstractions, allowing the structuring of a program to be highly concurrent at all levels. GRA

**N91-17606#** Stanford Univ., CA. Systems Optimization Lab.
**A SEQUENTIAL QUADRATIC PROGRAMMING ALGORITHM USING AN INCOMPLETE SOLUTION OF THE SUBPROBLEM**
Walter Murray and Francisco J. Prieto Sep. 1990 41 p
(Contract N00014-90-J-1242; NSF DDM-87-15153)
(AD-A228829; SU-SOL-90-12) Avail: NTIS HC/MF A03 CSCL 12/4

A feature of current sequential quadratic programming (SQP) methods to solve nonlinear constrained optimization problems is the necessity at each iteration to solve a quadratic program (QP). It is shown that if the QP subproblem is convex and an active-set method is used to solve it, then there exist iterates other than the minimizer that may be used to define a suitable search direction. None of the usual properties of an SQP method are compromised by the new definition of the search direction. Some new properties are derived for an SQP method that uses a particular augmented Lagrangian merit function. Specifically, under suitable additional assumptions, it is shown that the rate of convergence is superlinear. It is also shown that the penalty parameter used in the merit function is bounded. GRA

**N91-17607#** Los Alamos National Lab., NM.
**ACCELERATION OF CONVERGENCE**
Lawrence Auer 1990 11 p Presented at the NATO Advanced Workshop on Stellar Atmospheres: Beyond Classical Models, Trieste, Italy, 3-7 Sep. 1990
(Contract W-7405-eng-36)
(DE91-004860; LA-UR-90-4022; CONF-9009308-3) Avail: NTIS HC/MF A03

Acceleration of the convergence of approximate operator iteration schemes is discussed. Algorithms based on both residual minimization and use of conjugate vector spaces are presented. It is shown that both give dramatic improvement, at very low computational cost, in the iterative solution of radiative transfer problems in the presence of scattering. DOE

**N91-17608#** Argonne National Lab., IL. Mathematics and Computer Science Div.
**FORMED: AN X WINDOW SYSTEM APPLICATION FOR MANAGING FIRST-ORDER FORMULAS**
Tamara L. Henry and William W. McCune Nov. 1990 13 p
(Contract W-31-109-eng-38)
(DE91-005214; ANL/MCS-TM-141) Avail: NTIS HC/MF A03

FormEd is a window-based program for constructing, displaying, and managing first-order logic formulas. The main motivation for constructing FormEd was the desire to have formulas displayed in a readable, two-dimensional format. Users of FormEd can make two kinds of transformation on formulas: logic transformations, such as negation normal form translation, which preserve the meaning of a formula, and edit transformations, which can be used to make arbitrary changes, such as adding a hypothesis to a subformula. FormEd was written by using the X Window System, Version 11, and code from the theorem prover OTTER. DOE

**N91-17609#** Federal Aviation Administration, Atlantic City, NJ.
**NAS (HOST/ARTS 3A) TO VME MODEM INTERFACE ATC INTERFACE. HARDWARE MANUAL**
Leo J. Wapelhorst Oct. 1990 115 p
(DOT/FAA/CT-TN90/46) Avail: NTIS HC/MF A06

Reference materials for personnel using the National Airspace System (NAS) (HOST or ARTS IIIA) Air Traffic Control (ATC) Interface Subsystem is given. The material was originally developed to be part of the Data Link Test and Analysis System (DATAS) in order to provide an interface between the NAS and the Ground Data Link Processor (GDLP). Author

**N91-17610#** Bureau of Mines, Pittsburgh, PA.
**COMPUTER-AIDED SOFTWARE ENGINEERING (CASE) FOR SOFTWARE AUTOMATION**
J. J. Sammarco 1990 15 p
(PB91-110791; BUMINES-IC-9265; LC-90-2100) Avail: NTIS HC/MF A03 CSCL 09B

The U.S. Bureau of Mines is conducting research into

computer-assisted mining. New technologies such as computer-aided software engineering (CASE), is now available. What CASE is, its general features, and its importance in software development are explored. Information is presented to assist in selection and application of CASE tools. CASE technology encompasses a variety of tools and methods for automating the various stages of software development. When evaluating CASE, examine tools that support one's particular method(s) of software development. Also, examine support for existing hardware platforms. Merely selecting a good CASE tool does not insure success. Thoroughly evaluating the implementation of CASE into the organization is also critical. Subjects to evaluate for CASE implementation include the organization culture, support from management and the end-users, training resources, and pilot projects. The organizations benefiting the most from CASE evaluate CASE features with respect to their needs and properly implement CASE into the organization. GRA

**N91-17611*#** Texas Univ., Austin. Dept. of Electrical and Computer Engineering.
**REDUNDANCY MANAGEMENT FOR EFFICIENT FAULT RECOVERY IN NASA'S DISTRIBUTED COMPUTING SYSTEM Final Report**
Miroslaw Malek, Mihir Pandya, and Kitty Yau 15 Feb. 1991 41 p
(Grant NAG9-351)
(NASA-CR-187879; NAS 1.26:187879) Avail: NTIS HC/MF A03 CSCL 09B

The management of redundancy in computer systems was studied and guidelines were provided for the development of NASA's fault-tolerant distributed systems. Fault recovery and reconfiguration mechanisms were examined. A theoretical foundation was laid for redundancy management by efficient reconfiguration methods and algorithmic diversity. Algorithms were developed to optimize the resources for embedding of computational graphs of tasks in the system architecture and reconfiguration of these tasks after a failure has occurred. The computational structure represented by a path and the complete binary tree was considered and the mesh and hypercube architectures were targeted for their embeddings. The innovative concept of Hybrid Algorithm Technique was introduced. This new technique provides a mechanism for obtaining fault tolerance while exhibiting improved performance. Y.S.

**N91-17612*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
**GCS PROGRAMMER'S MANUAL**
Douglas S. Lowman, B. Edward Withers, Anita M. Shagnea, Leslie A. Dent (Research Triangle Inst., Research Triangle Park, NC.), and Kelly J. Hayhurst Dec. 1990 28 p
(NASA-TM-102721; NAS 1.15:102721) Avail: NTIS HC/MF A03 CSCL 09B

A variety of instructions to be used in the development of implementations of software for the Guidance and Control Software (GCS) project is described. This document fulfills the Radio Technical Commission for Aeronautics RTCA/DO-178A guidelines, 'Software Considerations in Airborne Systems and Equipment Certification' requirements for document No. 4, which specifies the information necessary for understanding and programming the host computer, and document No. 12, which specifies the software design and implementation standards that are applicable to the software development and testing process. Information on the following subjects is contained: activity recording, communication protocol, coding standards, change management, error handling, design standards, problem reporting, module testing logs, documentation formats, accuracy requirements, and programmer responsibilities. Author

**N91-17613*#** SRI International Corp., Menlo Park, CA.
**EVALUATION OF AN EXPERT SYSTEM FOR FAULT DETECTION, ISOLATION, AND RECOVERY IN THE MANNED MANEUVERING UNIT Final Report**
John Rushby and Judith Crow Dec. 1990 102 p
(Contract NAS1-18226)
(NASA-CR-187466; NAS 1.26:187466) Avail: NTIS HC/MF A06 CSCL 09B

The authors explore issues in the specification, verification, and validation of artificial intelligence (AI) based software, using a prototype fault detection, isolation and recovery (FDIR) system for the Manned Maneuvering Unit (MMU). They use this system as a vehicle for exploring issues in the semantics of C-Language Integrated Production System (CLIPS)-style rule-based languages, the verification of properties relating to safety and reliability, and the static and dynamic analysis of knowledge based systems. This analysis reveals errors and shortcomings in the MMU FDIR system and raises a number of issues concerning software engineering in CLIPs. The authors came to realize that the MMU FDIR system does not conform to conventional definitions of AI software, despite the fact that it was intended and indeed presented as an AI system. The authors discuss this apparent disparity and related questions such as the role of AI techniques in space and aircraft operations and the suitability of CLIPS for critical applications. Author

**N91-17614#** Naval Postgraduate School, Monterey, CA. Dept. of Administrative Sciences.
**TASKMASTER: A PROTOTYPE GRAPHICAL USER-INTERFACE TO A SCHEDULE OPTIMIZATION MODEL M.S. Thesis**
Stephen R. Banham Mar. 1990 90 p
(AD-A229011) Avail: NTIS HC/MF A05 CSCL 12/5

This thesis investigates the use of current graphical interface techniques to build more effective computer-user interfaces to operations research (OR) schedule optimization models. The design is directed at the scheduling decision maker who possesses limited OR experience. The feasibility and validity of building an interface for this kind of user is demonstrated in the development of a prototype graphical user interface called TaskMaster. TaskMaster is designed as the Dialog component of a scheduling decision support system (DSS). The underlying scheduling model uses set-partitioning and mixed-integer linear programming to generate optimal schedules. Although the model was originally developed to address a specific problem, inter-deployment scheduling of Navy surface ships, TaskMaster has been designed to be problem-independent, enabling it to address a broad range of scheduling problems with the same general structure. TaskMaster demonstrates the type of interactive, graphical interface that can be developed specifically for non-specialists. It is easy to learn and to use, yet fully exploits the power of a sophisticated OR scheduling model. The prototype is implemented on a NeXT computer, chosen for its advanced computational power and state-of-the-art graphical interface development tools. GRA

**N91-17615#** Naval Postgraduate School, Monterey, CA. Dept. of Administrative Sciences.
**AN INVESTIGATION OF THE METHODOLOGY FOR SOFTWARE TRANSLATION FROM PASCAL TO C OF AN UNDOCUMENTED MICROCOMPUTER PROGRAM M.S. Thesis**
Charles W. Bell Mar. 1990 121 p Sponsored by Defense Systems Management School, Fort Belvior, VA
(AD-A229033) Avail: NTIS HC/MF A06 CSCL 12/5

The purpose of this theses is to investigate software reusability applications and the practical utilization of those applications in the performance of software maintenance. The translation of a functioning program from one high level language to another was selected as the type of software reusability effort to the explored. Five translation methodologies were investigated and the inverse transformation methodology was chosen to exercise the practical application of software reusability for a specific case study. A design strategy and translation approach was developed based on the inverse transformation methodology. The translation approach was followed in performing the translation of the case study. The results of the applications of the methodology to the case study is described and the methodology is evaluated on its usefulness as a tool for software reuse. GRA

**N91-17616#** Honeywell, Inc., Golden Valley, MN. Sensor and System Development Center.
**DOS DESIGN/APPLICATION TOOLS, VOLUME 1 Final Technical Report, Dec. 1987 - Dec. 1989**
Sep. 1990 65 p
(Contract F30602-87-C-0104; AF Proj. 5581)
(AD-A229053; RADC-TR-90-203-VOL-1) Avail: NTIS HC/MF A04 CSCL 12/7

Developing applications for execution in a distributed data processing environment is a difficult task. Such environments dominate Air Force C3I systems, which are necessarily distributed. In addition to being a physical necessity, distributed systems offer, relative to centralized processing systems, the potential for increased performance and fault tolerance. Realizing that potential is a key objective behind research in distributed systems technology. The goal of this contract is to define and demonstrate a framework for integrating development tools, and to define and construct tools that support the development of distributed applications. A tool integration platform was designed and developed as a fundamental element of an integrated development framework. The RADC Distributed System Evaluation (DISE) Environment Tool Integration Platform integrates software development tools by automating and coordinating information exchange between tools, through use of the CRONUS distributed system and the ONTOS object oriented database management system. Two development tools were selected and implemented that illustrate the types of technology required to support distributed application development. The Allocator assists developers with determining efficient implementations for distributed applications. The Reliability Analyzer generates reliability measures for application components given a set of hardware reliabilities. The two tools have been integrated into the IP. GRA

**N91-17617#** Honeywell, Inc., Golden Valley, MN. Sensor and System Development Center.
**DOS DESIGN/APPLICATION TOOLS: SOFTWARE TOP-LEVEL DESIGN DOCUMENT, VOLUME 2 Final Technical Report, Dec. 1987 - Dec. 1989**
Sep. 1990 96 p
(Contract F30602-87-C-0101; AF Proj. 5581)
(AD-A229054; RADC-TR-90-203-VOL-2) Avail: NTIS HC/MF A05 CSCL 12/5

Developing applications for execution in a distributed data processing environment is a difficult task. Such environments dominate Air Force C3I systems, which are necessarily distributed. In addition to being a physical necessity, distributed systems offer, relative to centralized processing systems, the potential for increased performance and fault tolerance. Realizing that potential is a key objective behind research in distributed systems technology. The goal of this contract is to: (1) define and demonstrate a framework for integrating development tools; and (2) define and construct tools that support the development of distributed applications. A tool integration platform was designed and developed as a fundamental element of an integrated development framework. The RADC Distributed System Evaluation (DISE) Environment Tool Integration Platform integrates software development tools by automating and coordinating information exchange between tools, through use of the CRONUS distributed system and the ONTOS object oriented database management system. Two development tools were selected and implemented that illustrate the types of technology required to support distributed application development. The Allocator assists developers with determining efficient implementations for distributed applications. The Reliability Analyzer generates reliability measures for application components given a set of hardware reliabilities. The two tools have been integrated into the IP. GRA

**N91-17618#** Honeywell, Inc., Golden Valley, MN. Sensor and System Development Center.
**DOS DESIGN/APPLICATION TOOLS: SYSTEM/SEGMENT SPECIFICATION, VOLUME 3 Final Technical Report, Dec. 1987 - Dec. 1989**
Sep. 1990 40 p
(Contract F30602-87-C-0104; AF Proj. 5581)
(AD-A229055; RADC-TR-90-203-VOL-3) Avail: NTIS HC/MF A03 CSCL 12/7

Developing applications for execution in a distributed data processing environment is a difficult task. Such environments dominate Air Force C3I systems, which are necessarily distributed. In addition to being a physical necessity, distributed systems offer, relative to centralized processing systems, the potential for increased performance and fault tolerance. Realizing that potential is a key objective behind research in distributed systems technology. The goal of this contract is to define and demonstrate a framework for integrating development tools, and to define and construct tools that support the development of distributed applications. A tool integration platform was designed and developed as a fundamental element of an integrated development framework. The RADC Distributed System Evaluation (DISE) Environment Tool Integration Platform integrates software development tools by automating and coordinating information exchange between tools, through use of the CRONUS distributed system and the ONTOS object oriented database management system. Two development tools were selected and implemented that illustrate the types of technology required to support distributed application development. The Allocator assists developers with determining efficient implementations for distributed applications. The Reliability Analyzer generates reliability measures for application components given a set of hardware reliabilities. The two tools have been integrated into the IP. System functions, configuration allocation, interface requirements, and tool integration are discusssed. GRA

**N91-17619#** Army Engineer Waterways Experiment Station, Vicksburg, MS. Information Technology Lab.
**USER'S GUIDE: COMPUTER PROGRAM FOR TWO-DIMENSIONAL ANALYSIS OF U-FRAME OR W-FRAME STRUCTURES (CWFRAM) Final Report**
Thomas D. Jordan and William P. Dawkins Sep. 1990 260 p
Sponsored by Corps of Engineers, Washington, DC
(AD-A229059; WES/IR/ITL-90-6) Avail: NTIS HC/MF A12 CSCL 12/5

The interactive computer program CWFRAM, described in this user's guide, performs an analysis of a two-dimensional slice of a U-frame or W-frame structure. The program functions in two modes, equilibrium and frame analysis. In the equilibrium mode, the program converts soil and/or water effects to surface loads on the structure, determines the resultants of all applied loads, and determines the necessary base-reaction distribution to equilibrate the external loads. In the frame analysis mode, a model of the structure is formulated and displacements and internal forces throughout the structure are determined from a linearly elastic analysis. Information regarding the response of the structure is provided by this program with no actual design functions nor judgment offered as to the quality of the structural performance. Under certain conditions outlined herein, an analysis of a two-dimensional slice provides comparatively reliable indications concerning the behavior of the three-dimensional systems. GRA

**N91-17620#** Colorado Univ., Boulder. Dept. of Computer Science.
**INTELLIGENT SUPPORT SYSTEMS FOR HYPERKNOWLEDGE Interim Report**
Gerhard Fischer Jul. 1990 22 p
(Contract MDA903-86-C-0143; NSF DCR-84-20944)
(AD-A229109; ARI-RN-90-53) Avail: NTIS HC/MF A03 CSCL 12/5

Computer systems can assist in searching, understanding, and knowledge in creative problem-solving. We have explored this idea in the context of building a variety of intelligent support systems for high-functionality computer systems, emphasizing the following specific issues: representation of programs as knowledge networks where the code, the documentation, and visual representations are external representations generated from the same complex internal knowledge structure; user-definable filters to give users control of the parts they would like to see; constraint mechanisms

to maintain consistency between internal and external representations; different browsing systems to explore hyperknowledge spaces and design kits as prototypes of hyperknowledge assistants. To increase the usefulness of high-functionality computer systems, they should be constructed as hyperknowledge systems where the intelligent support systems are an integral part of the overall design. GRA

**N91-17621#** Kestrel Inst., Palo Alto, CA.
**THEORY OF ALGORITHM STRUCTURE AND DESIGN Report, 1 Oct. 1989 - 30 Sep. 1990**
Douglas R. Smith 5 Oct. 1990 13 p
(Contract N00014-90-J-1733)
(AD-A229115) Avail: NTIS HC/MF A03 CSCL 12/5

Algorithms and data structures are among the primary constituents of computer software and thus are among basic objects of study in computer science. This project is concerned with the structure and automated design of algorithms and data structures. Our scientific hypothesis is that there exist general algorithm, data structure, and design concepts that underlie and explain most of the detailed structure of conventional software systems. By abstracting and formalizing these concepts and showing how to mechanize their application, we can prepare the way for the coming generation of automated software design environments. Our approach involves identifying classes of algorithms that solve a broad range of useful problems. In particular, we have emphasized formalizing abstract algorithms that make minimal assumptions about the structure of a problem. Once a class of algorithms has been identified we represent its essence as an algorithm theory. GRA

**N91-17622#** Navy Center for Applied Research in Artificial Intelligence, Washington, DC. Information Technology Div.
**AN INVESTIGATION INTO THE USE OF HYPERMUTATION AS AN ADAPTIVE OPERATOR IN GENETIC ALGORITHMS HAVING CONTINUOUS, TIME-DEPENDENT NONSTATIONARY ENVIRONMENTS Memorandum Report**
Helen G. Cobb 11 Dec. 1990 21 p Sponsored by ONR, Arlington, VA
(AD-A229159; NRL-MR-6760) Avail: NTIS HC/MF A03 CSCL 12/9

Previous studies of Genetic Algorithm (GA) optimization in nonstationary environments focus on discontinuous, Markovian switching environments. This study introduces the problem of GA optimization in continuous, nonstationary environments where the state of the environment is a function of time. The objective of the GA in such an environment is to select a sequence of values over time that minimize, or maximize, the time-average of the environmental evaluations. In this preliminary study, we explore the use of mutation as a control strategy for having the GA increase or maintain the time-average best-of-generation performance. Given this context, the paper presents a set of short experiments using a simple, unimodal function. In each generation, the domain value mapping into the optimum changes so that the movement follows a sinusoidal path. In one of the experiments, we demonstrate the use of a simple adaptive mutation operator. During periods where the time-averaged best performance of the GA worsens, the GA enters hypermutation (a large increase in mutation); otherwise, the GA maintains a low level of mutation. GRA

**N91-17623*#** California Univ., Irvine. Dept. of Information and Computer Science.
**SOFTWARE SAFETY**
Nancy Leveson Jul. 1987 110 p
(Contract NCC9-16)
(NASA-CR-187920; NAS 1.26:187920) Copyright Avail: NTIS HC/MF A06 CSCL 09B

Software safety and its relationship to other qualities are discussed. It is shown that standard reliability and fault tolerance techniques will not solve the safety problem for the present. A new attitude requires: looking at what you do NOT want software to do along with what you want it to do; and assuming things will go wrong. New procedures and changes to entire software development process are necessary: special software safety analysis techniques are needed; and design techniques, especially eliminating complexity, can be very helpful. Y.S.

**N91-17624*#** Houston Univ., Clear Lake, TX. Research Inst. for Computing and Information Systems.
**PCLIPS Final Report**
Patrick D. Krolak (Lowell Univ., MA.) Dec. 1990 37 p
(Contract NCC9-16)
(NASA-CR-187915; NAS 1.26:187915) Avail: NTIS HC/MF A03 CSCL 09B

CLIPS is an expert system, created specifically to allow rapid implementation of an expert system. CLIPS is written in C, and thus needs a very small amount of memory to run. Parallel CLIPS (PCLIPS) is an extension to CLIPS which is intended to be used in situations where a group of expert systems are expected to run simultaneously and occasionally communicate with each other on an integrated network. PCLIPS is a coarse-grained data distribution system. Its main goal is to take information in one knowledge base and distribute it to other knowledge bases so that all the executing expert systems are able to use that knowledge to solve their disparate problems. Y.S.

**N91-17625*#** Computer Sciences Corp., Hampton, VA.
**SPACECRAFT ORBIT DESIGN AND ANALYSIS (SODA). VERSION 2.0: USER'S GUIDE**
Scott S. Stallcup, John S. Davis, and Jeffrey S. Zsoldos Jan. 1991 72 p
(Contract NAS1-19038)
(NASA-CR-187494; NAS 1.26:187494; TAO-60057) Avail: NTIS HC/MF A04 CSCL 09B

The Spacecraft Orbit Design and Analysis (SODA) computer program, Version 2.0, is discussed. SODA is a spaceflight mission planning system that consists of six program modules integrated around a common database and user interface. SODA runs on a VAX/VMS computer with an Evans and Sutherland PS300 graphics workstation. In the current version, three program modules produce an interactive three dimensional animation of one or more satellites in planetary orbit. Satellite visibility and sensor coverage capabilities are also provided. Circular and rectangular, off nadir, fixed and scanning sensors are supported. One module produces an interactive three dimensional animation of the solar system. Another module calculates cumulative satellite sensor coverage and revisit time for one or more satellites. Currently, Earth, Moon, and Mars systems are supported for all modules except the solar system module. Author

**N91-17626*#** Charles River Analytics, Inc., Cambridge, MA.
**SOFTWARE RELIABILITY EXPERIMENTS DATA ANALYSIS AND INVESTIGATION**
J. Leslie Walker and Alper K. Caglayan Jan. 1991 64 p Prepared for Draper (Charles Stark) Lab., Cambridge, MA
(Contract NAS1-18061)
(NASA-CR-187492; NAS 1.26:187492) Avail: NTIS HC/MF A04 CSCL 09B

The objectives are to investigate the fundamental reasons which cause independently developed software programs to fail dependently, and to examine fault tolerant software structures which maximize reliability gain in the presence of such dependent failure behavior. The authors used 20 redundant programs from a software reliability experiment to analyze the software errors causing coincident failures, to compare the reliability of N-version and recovery block structures composed of these programs, and to examine the impact of diversity on software reliability using subpopulations of these programs. The results indicate that both conceptually related and unrelated errors can cause coincident failures and that recovery block structures offer more reliability gain than N-version structures if acceptance checks that fail independently from the software components are available. The authors present a theory of general program checkers that have potential application for acceptance tests. Author

**N91-17627*#** Houston Univ., Clear Lake, TX. Hypermedia Working Group.
**HYPERMEDIA AND VISUAL TECHNOLOGY**
Lloyd Walker 1990 19 p Presented at the Hypermedia and Information Reconstruction Conference, Houston, TX, 3 Dec. 1990
(Contract NCC9-16)
(NASA-CR-187933; NAS 1.26:187933) Avail: NTIS HC/MF A03 CSCL 09B

Applications of a codified professional practice that uses visual representations of the thoughts and ideas of a working group are reported in order to improve productivity, problem solving, and innovation. This visual technology process was developed under the auspices of General Foods as part of a multi-year study. The study resulted in the validation of this professional service as a way to use art and design to facilitate productivity and innovation and to define new opportunities. It was also used by NASA for planning Lunar/Mars exploration and by other companies for general business and advanced strategic planning, developing new product concepts, and litigation support. General Foods has continued to use the service for packaging innovation studies.
Author

**N91-17038*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
**ADVANCED SOFTWARE INTEGRATION: THE CASE FOR ITV FACILITIES**
John R. Garman *In* NASA, Washington, Space Transportation Avionics Technology Symposium. Volume 2: Conference Proceedings Aug. 1990 p 475-487 (For primary document see N91-17020 09-06)
Avail: NTIS HC/MF A99 CSCL 09B

# 62 COMPUTER SYSTEMS

Includes computer networks and special application computer systems.

**N91-17628#** Technische Univ., Eindhoven (Netherlands). Dept. of Mathematics and Computing Science.
**MEASURING AND SIMULATING AN 802.3 CSMA/CD LAN**
Jan vanOorschot (Technische Univ., Delft, Netherlands ) and Anton Dekkers Jul. 1990 19 p
(MEMO-COSOR-90-26; ETN-91-98440) Avail: NTIS HC/MF A03

A single 802.3 Carrier Sense Multiple Access (CSMA)/CD Local Area Network (LAN) segment is measured resulting in throughput response times for several workloads and workstation parameters. During the measurements, the network carried an artificial workload with the characteristics of a real life workload. A simulation of the laboratory test is developed using the artificial workload parameters and the 802.3 CSMA/CD standard of the CCITT. The measurements showed that it is possible to determine the workstation parameters with great accuracy using simple throughput measurements on an empty network. It is then possible to isolate exact ethernet parameters during throughput measurements on a network with known workload. The behavior measured is reproduced in a simple simulation. The results of the simulation conform to the measured values. Some conclusions are that a 802.3 CSMA/CD segment can be measured and simulated with accurate results. This test environment is used to model a real life ethernet network in circumstances that can not be measured in a real life situation. Parameters that can be used to fine tune the simulation are the interframe gap time, and the workstation distance on a network. ESA

**N91-17629#** Rochester Univ., NY. Dept. of Computer Science.
**PARALLEL INCREMENTAL COMPILATION Ph.D. Thesis**
Neal M. Gafter Jun. 1990 126 p
(Contract N00014-82-K-0193)
(AD-A228726; TR-349) Avail: NTIS HC/MF A07 CSCL 12/5

The time it takes to compile a large program has been a bottleneck in the software development process. When an interactive programming environment with an incremental compiler is used, compilation speed becomes even more important, but existing incremental compilers are very slow for some types of program changes. A set of techniques are described that enable incremental compilation to exploit fine grained concurrency in a shared memory multiprocessor and achieve asymptotic improvement over sequential algorithms. Because parallel non-incremental compilation is a special case of parallel incremental compilation, the design of a parallel compiler is a corollary of the result. Instead of running the individual phases concurrently, the design specifies compiler phases that are mutually sequential. However, each phase is designed to exploit fine-grained parallelism. By allowing each phase to present its output as a complete structure rather than as a stream of data, techniques can be applied such as parallel prefix and parallel divide-and-conquer, and applicative data structures can be constructed to achieve sublinear execution time. Parallel algorithms for each phase of a compiler are presented to demonstrate that a complete incremental compiler can achieve execution time that is asymptotically less than sequential algorithms. GRA

**N91-17630#** Stanford Univ., CA. Dept. of Computer Science.
**QLISP FOR PARALLEL PROCESSORS Final Report, 30 Aug. 1988 - 28 Feb. 1990**
John McCarthy Nov. 1990 7 p
(Contract N00039-84-C-0211; ARPA Order 5826)
(AD-A228843) Avail: NTIS HC/MF A02 CSCL 12/5

Stanford University has completed the initial phase of the Qlisp project for research on parallel Lisp programming. The research made use of the Qlisp implementation on the Alliant FX/8 delivered by Lucid, Inc. under subcontract to Stanford University. The results confirm, in general, the predictions that a shared-memory multiprocessor is an effective tool for executing symbolic programs in Lisp. The major highlights of Qlisp were: (1) Demonstrating that Qlisp could be implemented as originally specified, and incorporating additional features that we found to be necessary or desirable; (2) Discovering the importance of dynamic control of parallelism; and (3) Implementing the basic parts of several major Lisp applications, and finding that Qlisp was a good vehicle for expressing the parallelism in these programs. The implementations of Qlisp proceeded with few difficulties. Several major enhancements to Lucid Common Lisp, that had been envisioned as necessary, were performed. These include deep binding (for special variables); support for multiple control stacks; and the removal or synchronization of many parts of the system that otherwise would not run correctly in parallel. The control of parallelism at runtime was known from the start to be an important part of programming in Qlisp. GRA

**N91-17631#** Rochester Univ., NY. Dept. of Computer Science.
**INTERPROCESSOR INVOCATION ON A NUMA MULTIPROCESSOR**
Alan L. Cox, Robert J. Fowler, and Jack E. Veenstra Oct. 1990 16 p
(Contract N00014-82-K-0193; NSF CDS-88-22724)
(AD-A228930; TR-356) Avail: NTIS HC/MF A03 CSCL 12/7

On a distributed shared memory machine, the problem of minimizing accesses to remote memory modules is crucial for obtaining high performance. An object based, parallel programming system is described called OSMIUM to support experiments with mechanisms for performing invocations on remote objects. The mechanisms studied include: non-cached access to remote memory, data migration, and function-shipping using an interprocessor invocation protocol (IIP). The analyses and experiments indicate that IIP competes well with the alternatives, especially when the structure of user programs requires synchronized access to data structures. While these results are obtained on a NUMA multiprocessor, they are also applicable to systems that use hardware cache coherency techniques. GRA

**N91-17632#** Oak Ridge National Lab., TN. Engineering Physics and Mathematics Div.
**EARLY EXPERIENCE WITH THE INTEL IPSC/860 AT OAK RIDGE NATIONAL LABORATORY**
M. T. Heath, G. A. Geist, and J. B. Drake Sep. 1990 34 p
(Contract DE-AC05-84OR-21400)
(DE91-005602; ORNL/TM-11655) Avail: NTIS HC/MF A03

This report summarizes the early experience in using the Intel iPSC/860 parallel supercomputer at Oak Ridge National Laboratory. The hardware and software are described in some detail, and the machine's performance is studied using both simple computational kernels and a number of complete applications programs.
Author

**N91-17633#** Georgia Inst. of Tech., Atlanta.
**SUMMARY OF RECENT RESEARCH ACCOMPLISHMENTS ON STOCHASTIC NETWORK PROCESSES Final Report, 1 May 1989 - 30 Jun. 1990**
Richard F. Serfozo 30 Jun. 1990 8 p
(Grant AF-AFOSR-0407-89; AF Proj. 2304)
(AD-A228952; AFOSR-90-1089TR) Avail: NTIS HC/MF A02
CSCL 12/7

The aim of this research has been to develop stochastic network processes for modeling the movement of discrete units in networks. Primary examples are the movement of data packets in computer networks, the movement of parts and supplies in manufacturing plants or in military support systems, and the movement of smart cars and trucks on electronically monitored highways. The distinguishing feature of our research is the emphasis on the next generation of intelligent networks that will be the backbone of our computer, military and transportation systems. Most of the present theory of stochastic network processes is for unintelligent networks in which the nodes operate independently, the routes of units are independent and the units move one at a time. In an intelligent network, however, the processing at the nodes and the routing typically depend dynamically on the actual congestion, and units move concurrently. Examples of dependencies are routing units to avoid congested nodes, speeding up of processing as queues grow, splitting and merging of units, batch processing and distributed as parallel processing. Our general goal is to provide an understanding of intelligent networks by describing their stochastic behavior. GRA

**N91-17634#** Massachusetts Inst. of Tech., Cambridge. Lab. for Computer Science.
**CACHE COHERENCE PROTOCOLS FOR LARGE-SCALE MULTIPROCESSORS M.S. Thesis**
David Lars Chaiken Sep. 1990 156 p
(Contract N00014-87-K-0825)
(AD-A228982; MIT/LCS/TR-489) Avail: NTIS HC/MF A08
CSCL 12/6

Caches have the potential to provide multiprocessors with an automatic mechanism for reducing both network traffic and average memory access latency. However, cache-based systems must address the problem of cache coherence. This thesis presents the results of the search for a cache coherence solution for Alewife, a large-scale multiprocessor being built at MIT. The research focuses on coherence protocols that use a directory, a list of cached copies of data, to avoid the need for a system-wide broadcast mechanism. The structure and the implementation of a number of coherence schemes are evaluated with coupled and decoupled simulation techniques. In addition to comparing the protocols in terms of hardware overhead and performance, the thesis reports on the experience gained by implementing several different schemes in ASIM, the Alewife machine simulator. The protocol search reaches two major conclusions: First, by using system-level optimizations, it is possible to use caches to build large-scale shared-memory multiprocessors. Second, the Alewife machine should use the integrated systems approach -- handling common cases in hardware and exceptional cases in software -- to solve the cache coherence problem. GRA

**N91-17635#** Mitre Corp., McLean, VA.
**CELLULAR AUTOMATA AND PARALLEL PROCESSING FOR PRACTICAL FLUID-DYNAMICS PROBLEMS**
H. Abarbanel, K. Case, A. Despain, F. Dyson, M. Freedman, C. Max, D. Nelson, and O. Rothaus 20 Sep. 1990 94 p Sponsored by DOE, Washington, DC and DARPA
(AD-A229234; JSR-86-303) Avail: NTIS HC/MF A05 CSCL 12/9

The study undertook to examine the utility of cellular automata in physical science calculations, especially in fluid dynamics. The scope of the study was expanded to include several related topics which would be of some interest to our sponsors. These include: (1) a comparison of cellular automata (CA) techniques to conventional methods of solving the partial differential equations of fluid dynamics or other physical situations; and (2) the utility and status of using parallel or concurrent processing machines for doing either CA or conventional fluids calculations. GRA

**N91-17636#** Lawrence Livermore National Lab., CA. Theoretical Astrophysics Div.
**THE SHAPE OF THE INVISIBLE HALO: N-BODY SIMULATIONS ON PARALLEL SUPERCOMPUTERS**
Michael S. Warren, Wojciech H. Zurek, Peter J. Quinn, and J. K. Salmon (California Inst. of Tech., Pasadena.) 1990 9 p Presented at the Astrophysics Workshop: After the First Three Minutes, College Park, MD, 15-17 Oct. 1990 Sponsored in part by California Univ., San Diego, La Jolla
(Contract W-7405-eng-36)
(DE91-004846; LA-UR-90-3915; CONF-9010268-2) Avail: NTIS HC/MF A02

The shapes were studied of halos and the relationship to their angular momentum content by means of N-body (N approx. 10(exp 6)) simulations. Results indicate that in relaxed halos with no apparent substructure: (1) the shape and orientation of the isodensity contours tends to persist throughout the virialized portion of the halo; (2) most (approx. 70 percent) of the halos are prolate; (3) the approximate direction of the angular momentum vector tends to persist throughout the halo; (4) for spherical shells centered on the core of the halo the magnitude of the specific angular momentum is approximately proportional to their radius; and (5) the shortest axis of the ellipsoid which approximates the shape of the halo tends to align with the rotation axis of the halo. This tendency is strongest in the fastest rotating halos. DOE

**N91-17637#** Oak Ridge National Lab., TN.
**THE USE OF PARALLEL COMPUTERS AND MULTIPLE SCATTERING GREEN FUNCTION METHODS IN CONDENSED MATTER PHYSICS Foreign Trip Report**
G. Malcolm Stocks 30 Nov. 1990 5 p
(Contract DE-AC05-84OR-21400)
(DE91-005351; ORNL/FTR-3831) Avail: NTIS HC/MF A01

The traveler presented invited lectures Parallelizing the Multiple Scattering Korringa Kohn Rostoker (KKR) and KKR-Coherent Potential Approximation (CPA) Codes at a workshop on Parallel Codes and Algorithms for Electronic Structure of Solids, held at the Science and Engineering Research Council (SERC) Daresbury Laboratory, and SCF-KKR-CPA Calculations at a meeting on KKR and related scattering theory, held at the University of Bristol. The Daresbury meeting reviewed the use of massively parallel computers in condensed matter physics, an area in which ORNL is playing a leading role. The Bristol meeting highlighted the great progress that has been made in recent years in the first principles theory and calculation of the properties of materials based on multiple-scattering Green function methods. This is an area in which, historically, ORNL has had a strong presence. The traveler collaborated with scientists at SERC Daresbury Laboratory on the use of the massively parallel INTEL i860 supercomputer in the calculation of the electronic and ground state properties of alloys and high (Tc) superconductors. At the Universities of Warwick and Bristol, the traveler collaborated with Dr. J. B. Staunton and Prof. B. L. Gyorffy on spin, charge, and pairing fluctuations in the Hubbard model. DOE

**N91-17638#** Argonne National Lab., IL. Mathematics and Computer Science Div.
**BILINGUAL PARALLEL PROGRAMMING**
Ian Foster and Ross Overbeek 1990 14 p Presented at the 3rd Workshop on Parallel Programming and Compilers, Irvine, CA, 1-3 Aug. 1990
(Contract W-31-109-eng-38)
(DE91-006030; CONF-9008181-1) Avail: NTIS HC/MF A03

Numerous experiments have demonstrated that computationally intensive algorithms support adequate parallelism to exploit the potential of large parallel machines. Yet successful parallel implementations of serious applications are rare. The limiting factor is clearly programming technology. None of the approaches to parallel programming that have been proposed to date -- whether parallelizing compilers, language extensions, or new concurrent languages -- seem to adequately address the central problems of portability, expressiveness, efficiency, and compatibility with existing software. In this paper, we advocate an alternative approach to parallel programming based on what we call bilingual programming. We present evidence that this approach provides and effective solution to parallel programming problems. The key idea in bilingual programming is to construct the upper levels of applications in a high-level language while coding selected low-level components in low-level languages. This approach permits the advantages of a high-level notation (expressiveness, elegance, conciseness) to be obtained without the cost in performance normally associated with high-level approaches. In addition, it provides a natural framework for reusing existing code. DOE

# 63 CYBERNETICS

Includes feedback and control theory, artificial intelligence, robotics and expert systems.

For related information see also *54 Man/System Technology and Life Support.*

**N91-17639#** Edgerton, Germeshausen and Grier, Inc., Albuquerque, NM.
**CREATING NUMERIC CONTROL DOCUMENTS USING THE CADNETIX PHOTOPLOT EXTRACTOR**
Sherry A. Hoffman Hardage 1990 4 p Presented at the Rocky Mountain States Daizix User's Conference, Ft. Collins, CO, 18 May 1990
(Contract DE-AC08-88NV-10617)
(DE90-011198; EGG-10617-6067; CONF-9005188-1) Avail: NTIS HC/MF A01

A a presentation on programming a numerically controlled drilling machine to drill holes in printed circuit boards is documented. DOE

**N91-17640#** Calspan-Buffalo Univ. Research Center, NY.
**INTELLIGENT MULTI-MEDIA INTEGRATED INTERFACE PROJECT Final Report, Oct. 1987 - Oct. 1989**
J. G. Neal, S. C. Shapiro, C. Y. Thielman, J. R. Gucwa, J. M. Lammens, D. J. Funke, J. S. Byoun, R. Paul, Z. Dobes, and S. Glanowski et al Jun. 1990 270 p
(Contract F30601-87-C-0136; ARPA Order 6085)
(AD-A225973; RADC-TR-90-128) Avail: NTIS HC/MF A12 CSCL 23/2

The results of the Intelligent Multi Media Interfaces (IMMI) project are discussed. The IMMI project has been devoted to the application of artificial intelligence technology to the development of human computer interface technology that integrates speech input, speech output, natural language text, graphics, and deictic gestures for interactive dialogs between human and computer. These dialogs are modeled on the manner in which two people naturally communicate in coordinated multiple modalities when working at a graphics device. The goal was to develop multi modal human computer interface technology that enhances human-computer communication and is more capable of meeting the demands of modern information intensive systems. As part of this project, a knowledge based multi media interface system, called CUBRICON (the CUBRIC Intelligent CONversationalist), was developed as a proof-of-concept prototype. The CUBRICON system is described. GRA

**N91-17641#** Illinois Univ., Urbana-Champaign. Dept. of Computer Science.
**TOWARDS INTELLIGENT FINITE ELEMENT ANALYSIS M.S. Thesis**
Alejandro G. Blanco Sep. 1990 56 p
(Contract N00014-86-K-0309)
(AD-A228672; UIUCDCS-R-90-1626; UILU-ENG-90-1765) Avail: NTIS HC/MF A04 CSCL 12/9

The aim is the use of various artificial intelligence (AI) techniques to improve the performance of programs performing finite element analysis, a method that numerically solves differential equations that govern a physical situation. Typically, a finite element program requires extensive analysis and frequent interruption by a scientist, which reduces how much the scientist can learn about the phenomenon being studied by consuming the scientist's resources and time in the drudgery of mathematically conditioning the input to the finite element program. This work usually has no relation to the matter being studied. Whether AI can be used to reduce the time spent doing this type of work is investigated. GRA

**N91-17642#** Massachusetts Inst. of Tech., Cambridge. Artificial Intelligence Lab.
**MODEL SELECTION FOR SOLVING KINEMATIC PROBLEMS M.S. Thesis**
Choon Phong Goh Sep. 1990 95 p
(Contract N00014-85-K-0124)
(AD-A228692; AI-TR-1257) Avail: NTIS HC/MF A05 CSCL 12/9

There has been much interest in the area of model-based reasoning within the Artificial Intelligence community, particularly in its application to diagnosis and troubleshooting. The core issue, simply put, is, model-based reasoning is fine, but whence the model? Where do the models come from? How do we know we have the right models? What does the right model mean anyway? The work has three major components. The first component deals with how to determine whether a piece of information is relevant to solving a problem. There are three ways of determining relevance: derivational, situational and an order-of-magnitude reasoning process. The second component deals with the defining and building of models for solving problems. We identify these models, determine what we need to know about them, and importantly, determine when they are appropriate. Currently, the system has a collection of four basic models and two hybrid models. This collection of models has been successfully tested on a set of fifteen simple kinematics problems. The third major component of the work deals with how the models are selected. GRA

**N91-17643#** Illinois Univ., Urbana-Champaign. Decision and Control Lab.
**SYSTEMATIC DESIGN OF ADAPTIVE CONTROLLERS FOR FEEDBACK LINEARIZABLE SYSTEMS**
Ioannis Kanellakopoulos, Petar V. Kokotovic, and A. Stephen Morse (Yale Univ., New Haven, CT.) Oct. 1990 35 p
(Grants AF-AFOSR-0110-90; NSF ECS-87-15811)
(AD-A228739; UILU-ENG-90-2249; DC-124) Avail: NTIS HC/MF A03 CSCL 12/2

A systematic procedure is developed for the design of adaptive regulation schemes for a class of feedback linearizable nonlinear systems. The coordinate-free geometric conditions, which characterize this class of systems, neither restrict the location of the unknown parameters, nor constrain in any way the growth of the nonlinearities. Instead, they require that the nonlinear system be transformable into the so-called pure-feedback form. This becomes now the broadest class of nonlinear systems for which an adaptive regulation scheme can be systematically designed. It is also shown that, under additional conditions, global stability properties can be established. GRA

**N91-17644** Texas Univ., Austin.
**DECISION-MAKING SOFTWARE FOR REDUNDANT MANIPULATORS Ph.D. Thesis**
Kevin Robert Cleary 1990 278 p
Avail: Univ. Microfilms Order No. DA9031542

This research provides the framework for the development of decision making software for redundant manipulators. A redundant manipulator has more than six degrees of freedom required to position and orient an object in space. The conclusion of the research is that an interactive, graphically based environment is necessary for effectively investigating the tradeoffs between diverse criteria. The self-motions of the manipulator provide the extra choices needed to satisfy the secondary criteria. By examining the self-motions of the manipulator at various points in the workplace, the idea of the range of possible criteria values can be obtained. The method of sequential filters can then be used to satisfy acceptable values for all the criteria while following a specified end effector trajectory. Dissert. Abstr.

# 64 NUMERICAL ANALYSIS

Includes iteration, difference equations, and numerical approximation.

**N91-17645#** Argonne National Lab., IL. High Energy Physics Div.
**QUANTUM MAPS FOR DEFORMED ALGEBRAS**
C. K. Zachos 1990 5 p Presented at the General Meeting of the Division of Particles and Fields of the American Physical Society, Houston, TX, 3-6 Jan. 1990
(Contract W-31-109-eng-38)
(DE90-010583; ANL-HEP-CP-90-07; CONF-900135-4) Avail: NTIS HC/MF A02

Explicit functionals were found that map SU(2) algebra generators to those of several quantum deformations of that algebra. How any such quantized algebra can be mapped to any other, and how representations of any such algebra can be expressed as simple functions of SU(2) representations are indicated. The representation theory and its comultiplication rules are thus systematized and streamlined by direct reference to their SU(2) correspondents. Quantum deformations of the Virasoro algebra are proposed. DOE

**N91-17646** New South Wales Univ., Kensington (Australia). School of Electrical Engineering and Computer Science.
**PROBABILISTIC SIMULATION OF POWER SYSTEM PRODUCTION USING ORTHOGONAL POLYNOMIAL EXPANSIONS Thesis Abstract Only**
W. D. Tian Mar. 1989 4 p
Avail: Issuing Activity

The main objective was to improve the accuracy of the cumulant method by using orthogonal polynomial expansions. Once the cumulants of the equivalent load were obtained, the probability density function and cumulative probability function of the equivalent load are approximated by orthogonal polynomial expansions which can be calculated from these cumulants. The Loss of Load Probability (LOLP), Energy Utilization Efficiency (EUE), and expected generating unit energies can be then calculated from these orthogonal polynomial expansions. Author

**N91-17647#** State Univ. of New York, Buffalo. Dept. of Electrical and Computer Engineering.
**HIGH SPEED SIGNAL PROCESSING CONCEPTS Final Technical Report, Jan. - Dec. 1989**
Adly T. Fam Sep. 1990 11 p
(Contract F30602-88-D-0025; AF Proj. 4519)
(AD-A227911) Avail: NTIS HC/MF A03 CSCL 12/5

Novel concepts and algorithms are presented for high throughput, arithmetic intensive applications in signal processing and communications. In addition, efficient implementations of these algorithms in a variety of modalities, including VLSI, and consideration of reliability and fault-tolerance issues are included. The highlights of the achievements of this effort are: (1) Linear phase FIR filters with computational efficiency of IIR filters; (2) VLSI implementation of FIR filters with binary coefficients based on redundancy removal techniques; (3) Optimal distribution of redundancy in hierarchical architectures, with faulty interconnects; (4) Commutative non-linearities and discrete filters; (5) Prime power to optimize the dynamic range of RNS-based computation; (6) Root coefficient space volume analysis sensitivity and resolution analysis; and (7) Robustness analysis of systems. GRA

**N91-17648#** Stanford Univ., CA.
**FUNCTIONAL KNOWLEDGE IN PROBLEM SOLVING**
James G. Greeno and Daniel Berger 9 Oct. 1990 79 p
(Contract N00014-88-K-0152)
(AD-A228694; GK-2) Avail: NTIS HC A05/MF A01 CSCL 05/8

An experiment compared solving operational and diagnostic problems after different instruction about a fictitious device. Solution of both kinds of problems was facilitated by instruction (1) that focused on functional relations among components of the device or (2) that focused on states of the individual components. For operational problems, this result contrasted with an earlier finding (Greeno & Berger, 1987) that only functional instruction facilitated inference and learning of operational procedures. In this study, component instruction included information about the states of switches and all participants saw a diagram of the device with information about connections between components. Both results are consistent with a characterization of relevant device-model knowledge by Kieras (1984) as including knowledge of device topology: connections between components and relations of connections to the controlling operations and indicators of the device. Comparison of information in the instructional conditions with planning nets for the operating procedures showed that functional instruction included needed information about connections between components and that component instruction included needed information about states of switches that determine connections between components. GRA

**N91-17649#** Purdue Univ., West Lafayette, IN. Dept. of Computer Sciences.
**CONVERSION METHODS BETWEEN PARAMETRIC AND IMPLICIT CURVES AND SURFACES**
Christopher M. Hoffmann Apr. 1990 65 p
(Contract N00014-90-J-1599; NSF OCR-86-19817)
(AD-A228715; CSD-TR-975) Avail: NTIS HC/MF A04 CSCL 12/1

Methods are presented for parameterizing implicit curves and surfaces and for implicitizing parametric curves and surfaces, based on computational techniques from algebraic geometry. After reviewing the basic mathematical facts of relevance, state-of-the-art algorithms and insights for the conversions problem are described and illustrated. GRA

**N91-17650#** Brown Univ., Providence, RI. Center for Dynamical Systems.
**A MONTE CARLO METHOD FOR SENSITIVITY ANALYSIS AND PARAMETRIC OPTIMIZATION OF NONLINEAR STOCHASTIC SYSTEMS: THE ERGODIC CASE**
Harold J. Kushner and Jichuan Yang Aug. 1990 51 p
(Contract DAAL03-86-K-0171; AF-AFOSR-0015-89; NSF ECS-89-13351; AF Proj. 2301)
(AD-A228946; LCDS-90-6; AFOSR-90-1136TR) Avail: NTIS HC/MF A04 CSCL 12/3

For high dimensional or nonlinear problems there are serious limitations on the power of available computational methods for the optimization or parametric optimization of stochastic systems of diffusion type. An effective Monte Carlo method is developed for obtaining good estimators of systems sensitivities with respect to system parameters, when the system is interest over a long period of time. The value of the method is borne out by numerical experiments, and the computational requirements are favorable with respect to competing methods when the dimension is high or the nonlinearities severe. The method is a type of derivative of

likelihood ratio method method. For a wide class of problems, the cost function or dynamics need not be smooth in the state variables; for example, where the cost is the probability of an event or sign functions appear in the dynamics. Under appropriate conditions, it is shown that the invariant measures are differentiable with respect to the parameters. Since the basic diffusion (or other) model cannot be simulated exactly, simulatable approximations are discussed in detail, and estimators are obtained and analyzed. It is shown that these estimators and their expectations converge to those for the original problem. GRA

**N91-17651** Texas Univ., Arlington.
**DEVELOPMENT AND APPLICATION OF AN INTEGRAL METHOD FOR NONLINEAR ELLIPTIC PROBLEMS Ph.D. Thesis**
Muralidharan Nair 1990 203 p
Avail: Univ. Microfilms Order No. DA9033491

An integral method is used to solve a sequence of problems, leading from the Laplace equation, through Poisson and Helmholtz, to the Navier-Stokes equations. The Direct, Formal Integration Method involves three steps: (1) formally integrate along a chosen trajectory; (2) resulting Volterra-forms are studied for new physical, mathematical, and numerical insights; and (3) solve the Volterra-forms numerically by an improved micro-Picard iteration. Dissert. Abstr.

**N91-17652** Deutsche Geodaetische Kommission, Munich (Germany, F.R.).
**CALCULATION OF MINIMUM VALUE DOMAINS FOR POINT POSITIONS IN SPATIAL NETWORKS OUT OF OBSERVATION PRESET TOLERANCES Ph.D. Thesis - Tech. Univ. Munich [BERECHNUNG MINIMALER WERTEBEREICHE VON PUNKTLAGEN IN RAEUMLICHEN NETZEN AUS VORGEGEBENEN TOLERANZEN DER BEOBACHTUNGEN]**
Hans Otto Schmidbauer 1989 105 p In GERMAN
(SER-C-355; ISBN-3-7696-9303-1; ISSN-0065-5325; ETN-91-98638) Copyright Avail: Deutsche Geodaetische Kommission, D-8000 Munich 22, Marstallplatz 8, Postfach 220 002, Fed. Republic of Germany

An algorithm for the computation of the three dimensional projection aggregate of an M polyhedron is presented. Using the process, the maximum possible value domains for the coordinates of single new points or the maximum value domains for the coordinate differences of two new points can be calculated. The strict three dimensional projection groups can be circumscribed by tangential bodies, by which the position of the tangential planes is given. The tolerance prism is defined as a special case among possible approximations by tangential bodies. This tolerance prism covers the three dimensional tolerance polyhedron in such a way that position and height value domains of the tolerance prism can be observed separately. The developed algorithm is used for several networks, as examples. The results obtained are discussed. ESA

**N91-17653** Deutsche Geodaetische Kommission, Munich (Germany, F.R.).
**INVESTIGATION OF THE TRILATERATION PROBLEM (4,4,1, 1) [UNTERSUCHUNGEN ZUM TRILATERATIONSPROBLEM (4,4,1,1)]**
Oswald Giering 1990 31 p In GERMAN; ENGLISH summary Sponsored by Volkswagen-Siftung
(SER-A-106; ISBN-3-7696-8188-6; ISSN-0065-5309; ETN-91-98639) Copyright Avail: Deutsche Geodaetische Kommission, D-8000 Munich 22, Marstallplatz 8, Postfach 220 002, Fed. Republic of Germany

In three space the problem (4, 4, 1, 1) of trilateration consists in determining the relative positions of four points P(sub i) (i equal to 1,..., 4) and four points Q(sub j) (j equal to 1,..., 4) by measurement of the eighteen distances P(sub i)Q(sub j), P(sub 1)P(sub 2) and Q(sub 1)Q(sub 2). The tetrahedron P(sub 1)P(sub 2)Q(sub 1)Q(sub 2) forms part of each configuration of points P(sub i), Q(sub j) which are compatible with these distances. The determination of the other points P(sub i), Q(sub j) leads to the intersection of two plane algebraic curves of eight degrees at most. The investigation of these curves yields two one parameter continuous families of solutions defining a deformable ten and twelve bar linkage. ESA

**N91-17654#** Michigan Univ., Ann Arbor. Design Lab.
**A GEOMETRIC INVESTIGATION OF THE SKELETON OF CSG OBJECTS**
Debasish Dutta and Christopher M. Hoffmann (Purdue Univ., West Lafayette, IN.) 14 Feb. 1990 27 p
(Contract N00014-86-K-0465; NSF CCR-86-19817; NSF DMC-88-07550)
(AD-A229292) Avail: NTIS HC/MF A03 CSCL 12/1

This document describes an algorithm for computing the skeleton (medial-axis surface) of an object defined using constructive solid geometry (CSG). This surface is the locus of all points in the object's interior that have equal minimum distance from at least two distinct parts of the boundary. The skeleton can be used in blending, motion planning, medical tomography, computer vision, and in mesh generation. The authors also present a geometric analysis of Voronoi surfaces from which the skeleton is composed. GRA

**N91-17655#** Los Alamos National Lab., NM. Computer Research and Applications Group.
**INVERSE PROBLEMS SVD AND PSEUDO SVD**
V. Faber, G. Milton Wing, and John Zahrt 1990 8 p Presented at the American Mathematical Society/Society for Industrial and Applied Mathematics Meeting, Albuquerque, NM, Apr. 1990 Submitted for publication
(Contract W-7405-eng-36)
(DE91-005939; LA-UR-90-4409; CONF-9004272-1) Avail: NTIS HC/MF A02

Physical experiments often gives rise to integral equations of the first kind. If the detection equipment can be adjusted, that fact can lead to a kernel function that depends on one or more parameters. We address the general question of how to choose those parameters in such a way as to make the integral operator as well-conditioned as possible, thus optimizing the experiment. Attention is focused on the condition number of the discretized kernel and on its principal singular vector. Several examples are given and some preliminary general results are obtained. DOE

**N91-17656#** Los Alamos National Lab., NM. Theoretical Div.
**THE NONLINEAR SCHROEDINGER EQUATION ON A DISORDERED CHAIN**
Rainer Scharf and A. R. Bishop 1990 28 p Presented at the Physics Nonlinearity with Disorder International Workshop, Tashkent, USSR, 1-7 Oct. 1990
(Contract W-7405-eng-36; NATO-RG674-88)
(DE91-005881; LA-UR-90-4214; CONF-9010286-1) Avail: NTIS HC/MF A03

The integrable lattice nonlinear Schroedinger equation is a unique model with which to investigate the effects of disorder on discrete integrable dynamics and its interplay with nonlinearity. We first review some features of the lattice nonlinear Schroedinger equation in the absence of disorder and introduce a 1- and 2-soliton collective variable approximation. Then we describe the effect of different types of disorder: attractive and repulsive isolated impurities, spatially periodic potentials, random potentials, and time dependent (kicked) long wavelength perturbations. DOE

**N91-17657#** Argonne National Lab., IL. Mathematics and Computer Science Div.
**AUTOMATIC EVALUATION OF FIRST- AND HIGHER-DERIVATIVE VECTORS**
Andreas Griewank 1990 15 p Presented at the Conference on Bifurcation and Chaos: Analysis, Algorithms, Applications, Wurzburg, Fed. Republic of Germany, 20-24 Aug. 1990
(Contract W-31-109-eng-38)
(DE91-006028; CONF-9008179-1) Avail: NTIS HC/MF A03

The numerical analysis of parameter-dependent nonlinear systems almost always involves first-derivative matrices and often

also requires the evaluation of higher derivatives along certain singular directions. It is shown here how these selected derivative values can be obtained without differencing and at a reasonable cost under the realistic assumption that the nonlinear system is given in the form of a computer program for its evaluation. DOE

**N91-17658*#** Institute for Computer Applications in Science and Engineering, Hampton, VA.
**ONE SHOT METHODS FOR OPTIMAL CONTROL OF DISTRIBUTED PARAMETER SYSTEMS 1: FINITE DIMENSIONAL CONTROL Final Report**
Shlomo Taasan (Weizmann Inst. of Science, Rehovoth, Israel ) Jan. 1991 23 p Submitted for publication
(Contract NAS1-18605; AF-AFOSR-0127-86)
(NASA-CR-187497; ICASE-91-2; NAS 1.26:187497) Avail: NTIS HC/MF A03 CSCL 12A

The efficient numerical treatment of optimal control problems governed by elliptic partial differential equations (PDEs) and systems of elliptic PDEs, where the control is finite dimensional is discussed. Distributed control as well as boundary control cases are discussed. The main characteristic of the new methods is that they are designed to solve the full optimization problem directly, rather than accelerating a descent method by an efficient multigrid solver for the equations involved. The methods use the adjoint state in order to achieve efficient smoother and a robust coarsening strategy. The main idea is the treatment of the control variables on appropriate scales, i.e., control variables that correspond to smooth functions are solved for on coarse grids depending on the smoothness of these functions. Solution of the control problems is achieved with the cost of solving the constraint equations about two to three times (by a multigrid solver). Numerical examples demonstrate the effectiveness of the method proposed in distributed control case, pointwise control and boundary control problems. Author

**N91-17659*#** Institute for Computer Applications in Science and Engineering, Hampton, VA.
**RECENT DEVELOPMENTS IN SHOCK-CAPTURING SCHEMES Final Report**
Ami Harten (Tel-Aviv Univ., Israel ) Jan. 1991 14 p Proceedings of the International Congress of Mathematicians held in Kyoto, Japan, 1990 Prepared in cooperation with California Univ., Los Angeles
(Contract NAS1-18605)
(NASA-CR-187502; ICASE-91-8; NAS 1.26:187502) Avail: NTIS HC/MF A03 CSCL 12A

The development of the shock capturing methodology is reviewed, paying special attention to the increasing nonlinearity in its design and its relation to interpolation. It is well-known that higher-order approximations to a discontinuous function generate spurious oscillations near the discontinuity (Gibbs phenomenon). Unlike standard finite-difference methods which use a fixed stencil, modern shock capturing schemes use an adaptive stencil which is selected according to the local smoothness of the solution. Near discontinuities this technique automatically switches to one-sided approximations, thus avoiding the use of discontinuous data which brings about spurious oscillations. Author

# 65 STATISTICS AND PROBABILITY

Includes data sampling and smoothing; Monte Carlo method; and stochastic processes.

**N91-17660#** Southern Methodist Univ., Dallas, TX. Dept. of Statistical Science.
**APPROXIMATING TAIL PROBABILITIES OF NONCENTRAL DISTRIBUTIONS**
Suojin Wang and H. L. Gray 19 Oct. 1990 18 p Submitted for publication
(Contract F19628-88-K-0042)
(AD-A228426; SMU/DS/TR-245; GL-TR-90-0276) Avail: NTIS HC/MF A03 CSCL 12/3

Gray and Wang's (1991) general method for approximating tail probabilities is applied to the cases of noncentral x squared, F and t distributions. The validity of such applications is established. The resulting approximations are easy to compute. Numerical results show the great accuracy of the approximations for all three most commonly used noncentral distributions. GRA

**N91-17661#** Syracuse Univ., NY. Dept. of Electrical Engineering.
**ERROR BOUNDS AND ASYMPTOTIC PERFORMANCE UNDER MISMATCH OF MULTISENSOR DETECTION SYSTEMS Final Technical Report, Jun. - Sep. 1988**
D. Kazakos Jul. 1990 7 p
(Contract F30602-81-C-0169; AF Proj. 4506)
(AD-A228646; RADC-TR-90-148) Avail: NTIS HC/MF A02 CSCL 17/8

A binary detection problem, when the data are obtained from distant sensors, and modelled as stationary Gaussian processes, with different spectra is considered. It is also assumed that inaccurate versions of the true statistical models are utilized, and upper bounds to the probability of error, based on the Chernoff bounding approach are developed. Those bounds also converge to the asymptotic probability of error as the number of data points increased. Conditions for sustaining, in spite of mismatch, exponential convergence of the error probability to zero are also determined. GRA

**N91-17662#** Illinois Univ., Urbana. Dept. of Aeronautical and Astronautical Engineering.
**STOCHASTIC DYNAMICS AND BIFURCATION BEHAVIOR OF NONLINEAR NONCONSERVATIVE SYSTEMS IN THE PRESENCE OF NOISE Final Technical Report, 1 Aug. 1988 - 31 Jul. 1990**
N. S. Namachchivaya, Gerard Leng, Winmin Tien, Monica Doyle, and Sanjiv Talwar 31 Aug. 1990 232 p
(Grant AF-AFOSR-0233-88; AF Proj. 2302)
(AD-A228923; AAE-90-7; UILU-ENG-90-0507; AFOSR-90-1143TR) Avail: NTIS HC/MF A11 CSCL 12/3

The main objectives are to develop mathematical techniques to reduce the dimensionality of multidegree-of-freedom nonlinear systems near bifurcation points and to solve for the response statistics of the reduced system. The asymptotic behavior of nonlinear dynamical systems in the presence of noise is studied using the method of stochastic normal forms. The crucial point in the normal form computations is to find the resonant terms that cannot be eliminated through a nonlinear change of variables. Subsequent to reduction of the dimensionality, a Markovian approximation is used to obtain the associated stochastic normal forms. The key result is that the second order stochastic terms have to be retained in the normal form computations in order to capture the contributions of the stable modes stochastic components to the critical modes drift terms. It is also shown that the method of extended stochastic averaging is in fact equivalent to stochastic normal forms for a specified class of nonlinear systems. In addition, mean square stability of the response is obtained and the bifurcation behavior and associated stationary and transient probability density functions for the reduced stochastic system are determined. Finally, the general results are applied to the study of the dynamics of aircraft at high angles of attack, plates under gas flow, structures under follower forces, and propellant lines conveying pulsating fluid. GRA

**N91-17663#** Arizona State Univ., Tempe. Dept. of Mathematics.
**OBSERVABILITY OF SYSTEMS WITH COMPLICATED DYNAMICS Final Technical Report, 1 Aug. 1988 - 31 Jul. 1990**
Thomas J. Taylor 23 Oct. 1990 8 p
(Grant AF-AFOSR-0254-88; AF Proj. 2304)
(AD-A229004; AFOSR-90-1090TR) Avail: NTIS HC/MF A02 CSCL 12/3

Significant advances have been made in understanding the observability problem for systems with chaotic or otherwise complicated dynamics. Rigorous connections have been es-

tablished between the theory of stochastic noise and observations of deterministic dynamical systems which are chaotic or otherwise display a complicated dynamical structure. New techniques have been developed for implementing state estimation of chaotic dynamical systems in the presence of observational noise. A general sufficient condition has been established for the observability of a benchmark class of chaotic dynamical systems, the Anosov diffeomorphisms. GRA

**N91-17664#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
**CHARACTERIZATION OF MULTILAYER PERCEPTRONS AND THEIR APPLICATION TO MULTISENSOR AUTOMATIC TARGET DETECTION Ph.D. Thesis**
Dennis William Ruck Dec. 1990 118 p
(AD-A229035; AD-E501305; AFIT/DS/ENG/90-2) Avail: NTIS HC/MF A06 CSCL 12/9

The multilayer perceptron was extensively analyzed. A technique for analyzing the multilayer perceptron, the saliency measure, was developed which provides a measure of the importance of inputs. The method was compared to the conventional statistical technique of best features and shown to provide similar rankings of the input. Using the saliency measure, it is shown that the multilayer perceptron effectively ignores useless inputs and that whether it is trained using backpropagation or extended Kalman filtering, the weighting of the inputs is the same. The backpropagation training algorithm is shown to be a degenerate version of the extended Kalman filter. The extended Kalman algorithm is shown to outperform the backpropagation method in terms of classification accuracy versus training presentations; however, in terms of computational complexity, the backpropagation algorithm is shown to be highly efficient. The multilayer perceptron trained using backpropagation for classification is proved to be minimum mean squared-error approximation to the Bayes optimal discriminant functions. A simple technique for sensor fusion is shown to provide a statistically significant improvement in performance using absolute range and forward looking infrared imagery for target detection over the single sensor case. GRA

**N91-17665#** Illinois Univ., Chicago. Biometric Lab.
**APPROXIMATING MULTIVARIATE NORMAL ORTHANT PROBABILITIES Interim Report, 1 Jun. 1989 - 1 Jun. 1990**
Robert D. Gibbons, R. Darrell Bock (Chicago Univ., IL.), and Donald Hedeker 1 Jun. 1990 16 p
(Contract N00014-89-J-1104; NR Proj. RR0-4204)
(AD-A229129; REPT-90-1) Avail: NTIS HC/MF A03 CSCL 12/3

The probability integral of the multivariate normal distribution has received considerable attention since Sheppard (1900) and Pearson (1901) published their seminal work on the bivariate normal distribution. The purpose of this report is to present a fast and general approximation for rectangular regions of the multivariate normal distribution function based of Clark's approximation to the moments of the maximum of n jointly normal random variables. The performance of this approximation compared to special cases in which the exact results are known and error-bounded reduction formulae show the accuracy of the approximation to be adequate for many practical applications where multivariate normal probabilities are required. GRA

**N91-17666#** Lawrence Livermore National Lab., CA.
**THE ALIAS METHOD: A FAST, EFFICIENT MONTE CARLO SAMPLING TECHNIQUE**
James A. Rathkopf, Arthur L. Edwards, and Robert K. Smidt (California Polytechnic State Univ., San Luis Obispo.) 16 Nov. 1990 10 p Presented at the 1990 Nuclear Explosives Code Developers' Conference, Monterey, CA, 6-9 Nov. 1990
(Contract W-7405-eng-48)
(DE91-006244; UCRL-JC-105535; CONF-9011149-9) Avail: NTIS HC/MF A02

The alias method is a Monte Carlo sampling technique that offers significant advantages over more traditional methods. It equals the accuracy of table lookup and the speed of equal probable bins. The original formulation of this method sampled from discrete distributions and was easily extended to histogram distributions. The method was further extended to applications more germane to Monte Carlo particle transport codes: continuous distributions. The alias method was presented as originally derived and the extensions to simple continuous distributions represented by piecewise linear functions. A method was also presented to interpolate accurately between distributions tabulated at points other than the point of interest. Timing studies that demonstrate the method's increased efficiency over table lookup are presented and further speedup achieved is shown through vectorization. DOE

# 66 SYSTEMS ANALYSIS

Includes mathematical modeling; network analysis; and operations research.

**N91-17036*#** National Aeronautics and Space Administration, Washington, DC.
**OPERATIONS MANAGEMENT SYSTEM**
A. E. Brandli, R. E. Eckelkamp, C. M. Kelly, W. McCandless, and D. L. Rue (TRW Electronics and Defense Sector, Redondo Beach, CA.) *In its* Space Transportation Avionics Technology Symposium. Volume 2: Conference Proceedings Aug. 1990 p 451-462 (For primary document see N91-17020 09-06)
Avail: NTIS HC/MF A99 CSCL 12B

**N91-17037*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
**OPERATIONAL EFFICIENCY SUBPANEL ADVANCED MISSION CONTROL**
Peter Friedland *In* NASA, Washington, Space Transportation Avionics Technology Symposium. Volume 2: Conference Proceedings Aug. 1990 p 463-474 (For primary document see N91-17020 09-06)
Avail: NTIS HC/MF A99 CSCL 12B

**N91-17045*#** National Aeronautics and Space Administration, Washington, DC.
**NSTS OPERATIONS UTILIZATION DIRECTORATE**
John Morian *In its* Space Transportation Avionics Technology Symposium. Volume 2: Conference Proceedings Aug. 1990 p 591-636 (For primary document see N91-17020 09-06)
Avail: NTIS HC/MF A99 CSCL 12B

**N91-17055*#** National Aeronautics and Space Administration, Washington, DC.
**OPERATIONAL EFFICIENCY**
Dan Bland, Tom Davis (National Aeronautics and Space Administration. John F. Kennedy Space Center, Cocoa Beach, FL.), and Sandy Griffin *In its* Space Transportation Avionics Technology Symposium. Volume 2: Conference Proceedings Aug. 1990 p 727-750 (For primary document see N91-17020 09-06)
Avail: NTIS HC/MF A99 CSCL 12B

# 67 THEORETICAL MATHEMATICS

Includes topology and number theory.

**N91-17667#** Oak Ridge National Lab., TN.
**NUMERICAL CONSIDERATIONS IN COMPUTING INVARIANT SUBSPACES**
Jack J. Dongarra, Sven Hammarling (Numerical Algorithms Group Ltd., Oxford, England ), and James H. Wilkinson Nov. 1990 29 p Sponsored in part by Science Alliance, Tennessee Univ.
(Contract DE-AC05-84OR-21400)
(DE91-004928; ORNL/TM-11704) Avail: NTIS HC/MF A03

The computation of the invariant subspace of a matrix

corresponding to some given group of eigenvalues is considered. Two methods for computing the invariant subspace of a matrix are described: (1) the use of transformations to interchange the eigenvalues; (2) direct computation of the vectors. DOE

# 70 PHYSICS (GENERAL)

For precision time and time interval (PTTI) see *35 Instrumentation and Photography;* for geophysics, astrophysics or solar physics see *46 Geophysics, 90 Astrophysics,* or *92 Solar Physics.*

**N91-17668#** Texas Univ., Austin. Inst. for Fusion Studies.
**A KINETIC THEORY OF TRAPPED ELECTRON DRIVEN DRIFT WAVE TURBULENCE IN A SHEARED MAGNETIC FIELD**
F. Y. Gang, P. H. Diamond, and M. N. Rosenbluth (California Univ., San Diego, La Jolla.) Sep. 1990 45 p Sponsored in part by Alfred P. Sloan Research Fellowship and NSF
(Contract DE-FG05-80ET-53088)
(DE91-004302; DOE/ET-53088/456; IFSR-456) Avail: NTIS HC/MF A03

A kinetic theory of collisionless and dissipative trapped electron driven drift wave turbulence in a sheared magnetic field is presented. Weak turbulence theory is employed to calculate the nonlinear electron and ion responses and to derive a wave kinetic equation that determines the nonlinear evolution of trapped electron mode turbulence. Saturated fluctuation spectrum is calculated using the condition of nonlinear saturation. The turbulent transport coefficients are in turn calculated using saturated fluctuation spectrum. Due to the disparity in the three different radial scale lengths of the slab-like eigenmode: Delta trapped electron layer width, x sub t (turning point width) and x sub i (Landau damping point), Delta less than x sub t less than x sub i, we find that ion Compton scattering rather than trapped electron Compton scattering is the dominant nonlinear saturation mechanism. Ion Compton scattering transfers wave energy from short to long wavelengths where the wave energy is shear damped. As a consequence, a saturated fluctuation spectrum (vert bar phi vert bar sup 2 k sub theta) approximately k sub theta sup minus alpha alpha = 2 and 3 for the dissipative and collisionless regime, respectively occurs for k sub theta rho sub s less than 1 and is heavily damped for k sub theta rho sub s greater than 1. The predicted fluctuation level and transport coefficients are well below the mixing length estimate. This is due to the contribution of radial wavenumbers x sub t sup minus 1 less than k sub r le rho sub i sup minus 1 to the nonlinear couplings, the effect of radial localization of trapped electron response to a layer of width, Delta, and the weak turbulence factor I angle gamma sub e sup I/omega sub rvec kappa r angle sub rvec k less than 1, which enters the saturation level. DOE

**N91-17669#** National Inst. of Standards and Technology, Boulder, CO. Time and Frequency Div.
**TIME AND FREQUENCY USERS MANUAL, REVISED 1990**
G. Kamas and M. A. Lombardi Sep. 1990 160 p Revised
(PB91-107532; NIST/SP-559-REV-1) Avail: NTIS HC/MF A08; also available SOD HC $8.50 as 003-003-03050-3 CSCL 20C

The book on the time and frequency measurements is reviewed. A brief discussion of time scales is presented, the roles of the National Institute of Standards and Technology and other national laboratories are discussed, and it is explained how time and frequency are internationally coordinated. The available time and frequency services and their usage are also described. The accuracies that can be achieved with the different services and the pros and cons of using various calibration methods are discussed. Y.S.

**N91-17670** Lowell Univ., MA.
**THE APPLICATION OF AN EFFICIENT RECTANGULAR FINITE ELEMENT TO THE MODELING OF NONLINEAR ELECTROTHERMAL MEMORY SWITCHING STRUCTURES**
**Ph.D. Thesis**
Kuen-Liang Liao 1990 148 p
Avail: Univ. Microfilms Order No. DA9031229

Memory switching devices depend upon Joule heating to cause a thermally induced transition from a low to a high conductive state. The electric field and the temperature field are coupled because the electrical conductivity is a function of the temperature and the heat generated is a consequence of the current flow. The electrical conductivity also depends upon the electric field. When the thermal and electric material properties depend upon the temperature, the coupled field equations become nonlinear. The electric field is assumed to be quasi-static and the temperature field is transient. The finite element method, employing the Newton-Raphson iteration scheme, was applied to solve the fully coupled nonlinear electric and temperature field equations. The computation was very intensive for the nonlinear and coupled problem. A four-node rectangular element that could be integrated exactly was developed to reduce the computation time. In comparison with the models using four-node isoparametric element, models using four-node rectangular element were numerically solved three times faster with the same degree of accuracy. A numerical model was developed to simulate the switching process of an n(+)-i-n(+) structure polycrystalline silicon memory switching device. The temperature distribution, preswitching current-voltage characteristics, current density, threshold voltage, switching time, and the melting filament were obtained. Experimental and numerical results are in good agreement. Dissert. Abstr.

# 71 ACOUSTICS

Includes sound generation, transmission and attenuation. For noise pollution see *45 Environmental Pollution.*

**N91-17671*#** Sverdrup Technology, Inc., Brook Park, OH.
**INFLUENCE OF VANE SWEEP ON ROTOR-STATOR INTERACTION NOISE**
Edmane Envia and Edward J. Kerschen (Arizona Univ., Tucson.) Dec. 1990 168 p
(Grant NAG3-357)
(NASA-CR-187052; NAS 1.26:187052) Avail: NTIS HC/MF A08 CSCL 20A

The influence of vane sweep in rotor-stator interaction noise is investigated. In an analytical approach, the interaction of a convected gust representing the rotor viscous wake, with a cascade of cascade of finite span swept airfoils, representing the stator, is analyzed. The analysis is based on the solution of the exact linearized equations of motion. High frequency convected gusts for which noise generation is concentrated near the leading edge of airfoils is considered. In a preliminary study, the problem of an isolated finite span swept airfoil interacting with a convected gust is analyzed. Results indicate that sweep can substantially reduce the farfield noise levels for a single airfoil. Using the single airfoil model, an approximate solution to the problem of noise radiation from a cascade of finite span swept airfoils interacting with a convected gust is derived. A parametric study of noise generated by gust cascade interaction is carried out to assess the effectiveness of vane sweep in reducing rotor-stator interaction noise. The results show that sweep is beneficial in reducing noise levels. Rotor wake twist or circumferential lean substantially influences the effectiveness of vane sweep. The orientation of vane sweep must be chosen to enhance the natural phase lag caused by wake lean, in which case rather small sweep angles substantially reduce the noise levels. Author

# 72 ATOMIC AND MOLECULAR PHYSICS

Includes atomic structure, electron properties, and molecular spectra.

**N91-17672#** Oak Ridge National Lab., TN.
**CONVOY ELECTRONS**

Joachim Burgdoerfer (Tennessee Univ., Knoxville.) 1990 45 p Presented at the NATO Advanced Study Inst. on Interaction of Charged Particles with Solids and Surfaces, Alicante, Spain, 6-18 May 1990 Sponsored in part by NSF
(Contract DE-AC05-84OR-21400)
(DE90-011381; CONF-900582-1) Avail: NTIS HC/MF A03

Recent developments in the theory of the production and of the transport of convoy electrons through solids are reviewed. Similarities and differences to cusp electron emission in binary ion-atom collisions and to transport of free electrons through solids are highlighted. Recent observations of convoy electron emission in ion-surface collisions were observed at small glancing angles. DOE

**N91-17673#** Lawrence Livermore National Lab., CA.
**PHOTOELECTRON SPECTROSCOPY OF EXCITED MOLECULAR STATES**
V. McKoy, M. Braunstein, H. Rudolph, J. A. Stephens, S. N. Dixit, and D. L. Lynch (Nevada Univ., Reno.) Jul. 1989 19 p Presented at the 4th International Conference on Electron Spectroscopy, Honolulu, HI, 10-14 Jul. 1989
(Contracts W-7405-eng-48; DE-FG03-87ER-60513; NSF CHE-85-21391; AF-AFOSR-0039-87)
(DE90-012088; UCRL-102642; CONF-890738-4) Avail: NTIS HC A03

Resonance Enhanced Multiphoton Ionization (REMPI), coupled with high-resolution photoelectron spectroscopy, is becoming an important probe of the photoionization dynamics of molecular excited states at a quantum-state specific level. In this paper we will discuss some results of our studies of ionic rotational and vibrational distributions for REMPI of several small molecules such as H2O, O2, NO, OH, and CH which illustrate some dynamically important features of these processes. DOE

**N91-17674#** Los Alamos National Lab., NM.
**LIGHT HYPERNUCLEI AND HYPERON-NUCLEON INTERACTION**
J. Carlson and B. F. Gibson 1990 11 p Presented at the Los Alamos Meson Physics Facility Workshop, Los Alamos, NM, 11-13 Oct. 1990 Submitted for publication
(Contract W-7405-eng-36)
(DE91-004863; LA-UR-90-4041; CONF-9010264-1) Avail: NTIS HC/MF A03

Light Hypernuclei are a vital testing ground for our understanding of the Hyperon-Nucleon interaction. We have performed microscopic calculations of four and five-body hypernuclei using the Nijmegen nucleon-nucleon and hyperon-nucleon interactions. Our calculations include explicit Sigma degrees of freedom. These degrees of freedom are quite important since, in contrast to the Delta minus N mass difference of approx. 300 MeV, the Sigma resonance is only about 80 MeV above the Lambda. In addition, although there is no one-pion-exchange in the Lambda N diagonal channel, this longest-range term does contribute to the transition Lambda N minus Sigma N interaction. Our variational calculations show that the A=4 spin 0 ground state binding energy is well reproduced by the Nijmegen HN integration, a one-boson exchange model fit to the available scattering data. The spin 1 excited state and the A=5 ground state are strongly underbound, however. We demonstrate the importance of the strong tensor terms of the Nijmegen model, particularly those in the transition channel, in obtaining this result. The limited data currently available for hyperon-nucleon scattering must be greatly improved in order to place reasonable constraints on the interaction. DOE

**N91-17675#** Rutherford Appleton Lab., Chilton (England).
**PHENOMENOLOGICAL CONSEQUENCES OF HMRS PARTONS**
P. N. Harriman, A. D. Martin, R. G. Roberts, and W. J. Stirling (Durham Univ., England ) Jun. 1990 14 p Presented at Workshop on Hadron Structure Functions and Parton Distributions, Batavia, IL, 26-28 Apr. 1990
(RAL-90-036; DTP/90/36; ETN-91-98404) Avail: NTIS HC/MF A03

The HMRS global parton analysis to obtain a band of allowed gluon distributions with qualitatively different small x behavior is extended. The implications for various processes at high energy colliders are studied. In particular, W and Z production are studied as a function of collider energy. Predictions for the W + and - charge asymmetry with recent CDF measurements are compared. Proceeding up to SSC (high luminosity hadron collider) energies, a sizeable component of W and Z production at large rapidity is found which arises from a valence quark colliding with a parton with extremely small x (x less than 0.0001). HERA probing of the gluon distribution at x is discussed. ESA

**N91-17676#** Rutherford Appleton Lab., Chilton (England).
**PARTON DISTRIBUTIONS AT SMALL x**
J. Kwiecinski, A. D. Martin, W. J. Stirling (Durham Univ., England), and R. G. Roberts Jul. 1990 55 p Sponsored by Science Research Council, England and Durham Univ., England
(RAL-90-053; DTP/90/46; ETN-91-98405) Avail: NTIS HC/MF A04

A next to leading order QCD (Quantum Chromodynamics) analysis of the recent data for deep inelastic lepton-nucleon scattering and related processes, in which particular attention is paid to the forms of the parton distributions at very small x, is performed. The theoretical QCD results leading to the singular 1/(x sq) type of behavior of the gluon and sea quark distributions, as well as the modifications due to shadowing effects, are discussed in detail and incorporated into the analysis. The QCD shadowing corrections are significant for x approx. less than 0.001 even though the parton distributions are below their saturation limit. Predictions for the structure functions F sub 2 and F sub L accessible at HERA and for W and Z production up to LHC and SSC (high luminosity hadron colliders) energies, are given. The possibility of experiments at these colliders probing the parton distributions in the very small x region is discussed. ESA

**N91-17677#** National Inst. of Standards and Technology, Gaithersburg, MD.
**TECHNICAL ACTIVITIES 1989, MOLECULAR PHYSICS DIVISION**
Aug. 1990 262 p
(PB90-264086; NISTIR-4390) Avail: NTIS HC/MF A12 CSCL 20H

The technical activities of the National Institute of Standards and Technology Molecular Physics Division during the fiscal year 1989 are summarized. The activities span experimental and theoretical research in high resolution molecular spectroscopy, quantum chemistry and molecular dynamics, and include the development of frequency standards, critically evaluated spectral data, applications of spectroscopy to important scientific and technological problems, and the advancement of spectroscopic measurement methods and techniques. A listing is given of publications and talks by the division staff. GRA

**N91-17678#** California Univ., Santa Barbara. Dept. of Physics.
**EXACT THEORY OF ONE-PHONON AMPLITUDES IN DIFFRACTIVE ATOM-SURFACE SCATTERING Technical Report No. 32, 1 Jan. - 31 Dec. 1990**
Michael E. Flatte and M. A. Van-Hove, ed. 14 Nov. 1990 9 p Proceedings of the 3rd International Conference on the Structure of Surfaces, Springer Verlag, NY, 1991 Submitted for publication
(Contract N00014-89-J-1530)
(AD-A228928) Avail: NTIS HC/MF A02 CSCL 20/5

An expression is derived for the probability of creating or annihilating one long-wavelength surface or bulk phonon during a scattering event, which depends on the bulk elastic constants but is independent of the details of the atom-target potential and of force constant changes near the surface. This expression is exact if the inelastic scattering is weak (the meaning of which is explained in the text). This theory should be experimentally verifiable, e.g., for 20 meV He atoms scattered from a W-surface. GRA

**N91-17679#** Washington Univ., Seattle. Dept. of Physics.
**ELEMENTARY PARTICLE PHYSICS: EXPERIMENTAL**

Jere J. Lord, T. H. Burnett, and R. Jeffrey Wilkes 20 Sep. 1990 52 p
(Contract DE-AS06-88ER-40423)
(DE91-005574; DOE/ER-40423/18) Avail: NTIS HC/MF A04

We are continuing a research program in high energy experimental particle physics and particle astrophysics. Studies of high energy hadronic interactions were performed using several techniques, in addition, a high energy leptoproduction experiment was continued at the Fermi National Accelerator Laboratory. We are participants in a joint U.S./Japan program to study nuclear interactions at energies two orders of magnitude greater than those of existing accelerators. The data are being collected with balloon-borne emulsion chambers. The properties of nuclear interactions at these high energies will reveal whether new production mechanisms come into play due to the high nuclear densities and temperatures obtained. We carried out closely related studies of hadronic interactions in emulsions exposed to high energy accelerator beams. We are members of a large international collaboration which has exposed emulsion chamber detectors to beams of (32)S and (16)O with energy 60 and 200 GeV/n at CERN and 15 GeV/n at Brookhaven National Laboratory. The primary objectives of this program are to determine the existence and properties of the hypothesized quark-gluon phase of matter, and its possible relation to a variety of anomalous observations. Studies of leptoproduction processes at high energies involve two separate experiments, one using the Tevatron 500 GeV muon beam and the other exploring the greater than TeV regime. We are participants in Fermilab experiment E665 employing a comprehensive counter/streamer chamber detector system. During the past year we joined the DUMAND Collaboration, and have been assigned responsibility for development and construction of critical components for the deep undersea neutrino detector facility, to be deployed in 1991. In addition, we are making significant contributions to the design of the triggering system to be used.
DOE

**N91-17680** Max-Planck-Inst. fuer Physik und Astrophysik, Garching (Germany, F.R.). Werner-Heisenberg-Inst. fuer Physik.
**LIMITS ON COMPOSITENESS OF QUARKS AND LEPTONS FROM e+e- ANNIHILATION**
Hubert Kroha Jun. 1990 7 p Presented at 20th Rencontre de Moriond, Les Arcs, France, 1990
(MPE-PAE/EXP-EL-226; ETN-91-98616) Copyright Avail: Fachinformationszentrum Karlsruhe, 7514
Leopoldshafen-Eggenstein 2, Fed. Republic of Germany

Data of the CELLO experiment on pair production of electrons, muons, taus, and heavy quarks are investigated in terms of compositeness. CELLO performs simultaneously measurements of the differential cross sections for c(c bar) and b(b bar) production e+e- annihilation. Different methods are compared for treating the common normalization errors of the data points when fitting the predicted cross sections. Difficulties in the interpretation of experimental limits on a compositeness scale not mentioned in previous measurements are discussed. The composite scale turns out not to be the appropriate parameter to estimate effects of a possible substructure of quarks and leptons. Limits on it from different experiments can neither be compared nor combined with each other. Therefore an analysis of the combined data on fermion pair production from PEP and PETRA is performed. ESA

**N91-17681** Max-Planck-Inst. fuer Physik und Astrophysik, Garching (Germany, F.R.). Werner-Heisenberg-Inst. fuer Physik.
**HEAVY QUARK CHARGE ASYMMETRIES BELOW THE Z SUP 0 RESONANCE**
Hubert Kroha Jul. 1990 47 p Presented at 25th International Conference on High Energy Physics, Singapore, 2-8 Aug. 1990
(MPE-PAE/EXP-EL-227; ETN-91-98617) Copyright Avail: Fachinformationszentrum Karlsruhe, 7514
Leopoldshafen-Eggenstein 2, Fed. Republic of Germany

The status of charge asymmetry measurements for charm and bottom quarks below the Z(sup 0) resonance is reviewed. An up to date compilation including the latest results is given. The combined charged asymmetry measurements are used to determine world average values for the weak neutral current couplings of the heavy quarks and to set limits on flavor oscillations in the neutral B meson system and on a possible common substructure of electrons and heavy quarks. The value obtained combined with measurements from like sign dilepton production gives the first experimental confirmation for non-zero B(sup 0)sub 3 mixing, at a confidence level of more than 95 percent. Lower limits on the compositeness scale for electron and heavy quark contact interactions were obtained in the 1 to 3 TeV range (at 95 percent C.L.). ESA

**N91-17682** Max-Planck-Inst. fuer Physik und Astrophysik, Garching (Germany, F.R.). Werner-Heisenberg-Inst. fuer Physik.
**REINVESTIGATION OF COMPOSITENESS LIMITS FROM e+e- ANNIHILATION**
Hubert Kroha Aug. 1990 18 p Presented at 25th International Conference on High Energy Physics, Singapore, 2-8 Aug. 1990
(MPE-PAE/EXP-EL-230; ETN-91-98618) Copyright Avail: Fachinformationszentrum Karlsruhe, 7514
Leopoldshafen-Eggenstein 2, Fed. Republic of Germany

Data of the Positron Electron Positron (PEP) storage ring and the Positron-Electron Tandem Ring Accelerator (PETRA) experiments on lepton pair production is investigated in terms of compositeness. Different methods are compared for treating the common normalization errors of the data points when fitting the predicted cross sections. Difficulties in the interpretation of experimental limits on a compositeness scale not mentioned in previous measurements are discussed. The composite scale turns out not to be the appropriate parameter to estimate effects of a possible substructure of quarks and leptons. Limits on it from different experiments can neither be compared nor combined. A combined analysis of the cross section measurements at PEP and PETRA was therefore performed in order to determine to which extent new contact interactions can be excluded from present e+e- annihilation data. ESA

**N91-17683#** California Univ., Los Angeles. Dept. of Physics.
**COMPUTER SIMULATIONS OF RADIATION GENERATION FROM RELATIVISTIC ELECTRON BEAMS Final Technical Report, 1 Oct. 1987 - 30 Sep. 1990**
Anthony T. Lin 30 Sep. 1990 71 p
(Grant AF-AFOSR-0027-88; AF Proj. 2310)
(AD-A228969; AFOSR-90-1102TR) Avail: NTIS HC/MF A04
CSCL 09/3

In investigating the effects of magnetic field on the output power of a plasma filled Backward Wave Oscillator, it was found that within a certain range of magnetic field the growth rate of beam plasma cyclotron interaction is significantly larger than the conventional backward wave oscillation. Computer simulations of a 100 GHz electron cyclotron autoresonance master oscillator have been carried out. GRA

**N91-17684#** Oklahoma Univ., Norman. Dept. of Physics and Astronomy.
**RESONANCE ENERGIES AND WIDTHS FROM THE POLES OF THE MULTICHANNEL T MATRIX Final Technical Report, 1 Sep. 1984 - 31 Jul. 1990**
Deborah Kay Watson 2 Nov. 1990 6 p
(Grant AF-AFOSR-0379-84; AF Proj. 2301)
(AD-A229064; AFOSR-90-1145TR) Avail: NTIS HC/MF A02
CSCL 20/8

A multichannel iteration technique was developed to obtain accurate results for phase shifts from a smooth Schwinger K matrix. Applications were made to e + He+ phase shifts in one, two, and three channel approximations. A second project was started to study excited states of helium using dimensional analysis. A moment method is being used to solve the two-electron Schrodinger equation generalized to an arbitrary number of dimensions. GRA

**N91-17685#** Argonne National Lab., IL. Physics Div.
**SUB-BARRIER FUSION AND NEAR-BARRIER QUASI-ELASTIC SCATTERING**

J. J. Kolata, R. J. Tighe (Notre Dame Univ., IN.), S. H. Fricke, H. Esbensen, and S. Landowne 1990 10 p Presented at the Interface Between Nuclear Structure and Heavy-Ion Reaction Dynamics Conference, Notre Dame, IN, 24-26 May 1990
(Contract W-31-109-eng-38; NSF PHY-88-03035)
(DE91-006046; CONF-9005221-9) Avail: NTIS HC/MF A02

Elastic scattering of sup 32 S on sup 58,64 Ni and fusion of sup 32 S+ sup 58,64 Ni and sup 34 S+ sup 64 Ni have been measured at energies near the Coulomb barrier. Our results differ in several important respects from previous measurements on these systems. Coupled-channels calculations which explicitly allow for inelastic excitation and single-nucleon transfer reproduce the main features of the new data. Near-barrier elastic scattering of sup 48 Ca on sup 40 Ca has also been measured. These data provide evidence for the effect of strong coupling to positive Q-value channels other than single-nucleon transfer. DOE

**N91-17686#** Lawrence Livermore National Lab., CA.
**RESPONSE MATRIX MONTE CARLO FOR ELECTRON TRANSPORT**
Clinton T. Ballinger, Dale E. Nielsen, Jr., and James A. Rathkopf Nov. 1990 12 p Presented at the 1990 Nuclear Explosives Code Developers' Conference, Monterey, CA, 6-9 Nov. 1990 Submitted for publication
(Contract W-7405-eng-48)
(DE91-006248; UCRL-JC-105409; CONF-9011149-10) Avail: NTIS HC/MF A03

A Response Matrix Monte Carol (RMMC) method was developed for solving electron transport problems. This method was born of the need to have a reliable, computationally efficient transport method for low energy electrons (below a few hundred keV) in all materials. Today, condensed history methods are used which reduce the computation time by modeling the combined effect of many collisions but fail at low energy because of the assumptions required to characterize the electron scattering. Analog Monte Carlo simulations are prohibitively expensive since electrons undergo coulombic scattering with little state change after a collision. The RMMC method attempts to combine the accuracy of an analog Monte Carlo simulation with the speed of the condensed history methods. The combined effect of many collisions is modeled, like condensed history, except it is precalculated via an analog Monte Carol simulation. This avoids the scattering kernel assumptions associated with condensed history methods. Results show good agreement between the RMMC method and analog Monte Carlo. DOE

**N91-17687#** Rice Univ., Houston, TX.
**THEORETICAL ATOMIC COLLISION PHYSICS Progress Report, 1990-1991**
N. F. Lane 1990 16 p
(Contract DE-FG05-87ER-13751)
(DE91-006276; DOE/ER-13751/4) Avail: NTIS HC/MF A03

The theoretical atomic physics at Rice University focuses on obtaining a better understanding of the mechanisms that control inelastic collisions between excited atoms and atoms, molecules and ions. Particular attention is given to systems and processes that are of potential importance to advanced energy technologies. In the current year, significant progress has been made in quantitative studies of: quenching of low-Rydberg Na atoms in thermal energy collisions with He, Ne and Ar atoms; selective excitation resulting from charge transfer in collisions of highly stripped ions of He, Li, C, and with Li, Na and He atoms and H2 molecules at keV energies; differential elastic and single, and double electron transfer in He++ collisions with He at keV energies; inelastic electron-transfer in ultralow energy-energy (T = 8 to 80 K) collisions between He-3(+) and He-4 and He-4(+) and He-3; a formalism for ionization by electron impact of ions in dense, high temperature plasmas. DOE

**N91-17688#** Georgia Univ., Athens. Dept. of Physics and Astronomy.
**HIGH ENERGY HADRON-HADRON COLLISIONS Annual Progress Report**
T. T. Chou Nov. 1990 16 p
(Contract DE-FG09-84ER-40160)
(DE91-006387; DOE/ER-40160/7) Avail: NTIS HC/MF A03

Results of a study on high energy collision with the geometrical model are summarized in three parts: the elastic hadron-hadron collision, the inelastic hadron-hadron collision, and the e(+)e(-) annihilation. For elastic collisions, a simple expression for the proton matter distribution is proposed which fits well the elastic (bar p)p scattering from ISR to S(bar p)pS energies within the geometrical model. The proton form factor is of the dipole form with an energy-dependent range parameter. The (bar p)p elastic differential cross section at Tevatron energies obtained by extrapolation is in good agreement with experiments. For multiparticle emission processes a unified physical picture for hadron-hadron and e(+)e(-) collisions was proposed. A number of predictions were made, including the one that KNO-scaling does not obtain for e(+)e(-) two-jet events. An extension of the considerations within the geometrical model led to a theory of the momentum distributions of the outgoing particles which are found in good agreement with current experimental data. Extrapolations of results to higher energies have been made. The cluster size of hadrons produced in e(+)e(-) annihilation is found to increase slowly with energy. DOE

**N91-17689#** Argonne National Lab., IL. Materials Science Div.
**THE f-ELECTRON SYSTEMS: PUSHING BAND THEORY**
D. D. Koelling Aug. 1990 12 p Presented at the Seminar on Electronic Structure in the 1990's, Bad Honnef, Fed. Republic of Germany, 24-26 Jul. 1990
(Contract W-31-109-eng-38)
(DE91-006087; CONF-9007197-1) Avail: NTIS HC/MF A03

The f-electron orbitals have always been the incomplete atomic shell acting as a local moment weakly interacting with the remaining electronic structure in the minds of most people. So examining them using a band theory where one views them as itinerant once was -- and to some extent even today still is -- considered with some skepticism. Nonetheless, a very significant community has successfully utilized band theory as a probe of the electronic structure of the appropriate actinides and rare earths. Those people actually using the approach would be the first to declare that it is not the whole solution. Instead, one is pushing and even exceeding its limits of applicability. However, the appropriate procedure is to push the model consistently to its limits, patch where possible, and then look to see where discrepancies remain. I propose to offer a selected review of past developments (emphasizing the career to date of A. J. Freeman in this area), offer a list of interesting puzzles for the future, and then make some guesses as to the techniques one might want to use. DOE

**N91-17690#** Northeastern Univ., Boston, MA.
**TOPICS IN GAUGE THEORIES AND THE UNIFICATION OF ELEMENTARY PARTICLE INTERACTIONS Progress Report, 1 Mar. - 31 Dec. 1990**
Yogendra N. Srivastava and Michael T. Vaughn Dec. 1990 8 p
(Contract DE-FG02-85ER-40233)
(DE91-006687; DOE/ER-40233/6) Avail: NTIS HC/MF A02

The phenomenology was examined of low and medium p sub t physics, standard model results for macroscopic systems, same sign dilepton signals from massive Majorana neutrinos, Casimir effects for charged particles, further macroscopic effects in quantum electrodynamics, and n-particle amplitudes for large n beyond the tree approximation, and renormalization group analysis of unified gauge theories. DOE

# 73 NUCLEAR AND HIGH-ENERGY PHYSICS

Includes elementary and nuclear particles; and reactor theory.

For space radiation see *93 Space Radiation.*

**N91-17691#** Iowa State Univ. of Science and Technology, Ames. Dept. of Physics.

**INVESTIGATION OF PHYSICAL STRUCTURES AND INTERACTIONS AT HIGH ENERGY Technical Progress Report, 1 Feb. 1990 - 31 Jan. 1991**

E. Walter Anderson 1991 7 p

(Contract DE-AC02-85ER-40193)

(DE91-005582; DOE/ER-40193/4) Avail: NTIS HC/MF A02

Contract AC02-85ER-40193 supports the investigation of fundamental structures and interactions at high energy by the Iowa State University Alpha HEP Group. Three major activities constitute the present focus of our research. Experiment E-735, performed at the Fermilab Tevatron Collider, is a search for a deconfined quark-gluon plasma phase of hadronic matter predicted to occur when temperatures of 240 MeV are achieved. The primary data were obtained in 1988 to 1989, from these data the collaboration is analyzing the charged particle multiplicity and transverse momentum distributions of the produced secondaries. These measurements are regarded on theoretical grounds to be sensitive indicators of the formation of a high-temperature plasma. The TPC detector, installed in the PEP ring at SLAC, has accumulated about 60,000 hadronic events at 29 GeV center-of-mass energy. Several thousand events have high-precision vertex chamber measurements. Physics analysis of charmed quark events, in addition to a measurement of the QCD strong coupling, are in progress. Our identification and reconstruction of D(sup o), D*, and D(sub s), charmed mesons will be useful for subsequent B meson studies in the TPC detector. The SSC liquid argon major subsystem tests at BNL and studies of gauge boson identification and reconstruction for large SSC detectors are in progress. Several crucial problems related to calorimeter geometries, coil geometries, and discrimination methods in full SSC events have been solved, and work is in progress on a one million event test of WW scattering capability up to 2 TeV. Our participation in the subsystem proposal involves construction of the module, data-taking at the AGS, and data analysis. DOE

**N91-17692#** Argonne National Lab., IL.

**EXPERIMENTS WITH FERMILAB POLARIZED PROTON AND POLARIZED ANTIPROTON BEAMS**

A. Yokosawa 1990 9 p Presented at the 25th IUPAP International Conference on High Energy Physics, Singapore, 2-8 Aug. 1990

(Contract W-31-109-eng-38)

(DE91-006027; ANL-HEP-CP-90-46; CONF-900822-22) Avail: NTIS HC/MF A02

We summarize activities concerning the Fermilab polarized beams. They include a brief description of the polarized-beam facility, measurements of beam polarization by polarimeters, asymmetry measurements in the pi(sup o) production at high p(sub perpendicular) and in the lambda (Sigma sup o), pi(sup +/-), pi(sup o) production at large x(sub F), and delta(sigma)sub L (proton-proton, antiproton-proton) measurements. DOE

**N91-17693#** Westinghouse Hanford Co., Richland, WA.

**SP-100 DESIGN, SAFETY, AND TESTING**

Gary L. Smith, Carl M. Cox, and Michael M. Mahaffey Jul. 1990 8 p Presented at the American Nuclear Society Topical Meeting on Safety of Non-Commercial Nuclear Reactor Research and Irradiation Facilities, Boise, ID, 30 Sep. - 4 Oct. 1990 Revised

(Contract DE-AC06-87RL-10930)

(DE90-015374; WHC-SA-0817-REV-1; CONF-900917-12-REV-1) Avail: NTIS HC/MF A02

The SP-100 Program is developing a nuclear reactor power system that can enhance and/or enable future civilian and military space missions. The program is directed to develop space reactor technology to provide electrical power in the range of tens to hundreds of kilowatts. The major nuclear assembly test is to be conducted at the Hanford Site near Richland, Washington, and is designed to validate the performance of the 2.4-MWt nuclear and heat transport assembly. DOE

**N91-17694#** Maryland Univ., College Park. Lab. for Plasma Research.

**AN ELECTRON BEAM INJECTOR FOR PULSE COMPRESSION EXPERIMENTS**

J. G. Wang, E. Boggasch, D. Kehne, M. Reiser, T. Shea, and D. X. Wang 1990 18 p Presented at the Annual Meeting of the Division of Physics of Beams of the American Physical Society, Washington, DC, 16-19 Apr. 1990

(Contract DE-AC05-85ER-40216)

(DE91-005744; CONF-900495-3-VUGRAPHS) Avail: NTIS HC/MF A03

An electron beam injector has been constructed to study the physics of longitudinal pulse compression in the University of Maryland electron beam transport experiment. The injector consists of a variable-perveance gridded electron gun followed by three matching lenses and one induction linac module. It produces a 50 ns, 40 mA electron pulse with a 2.5 to 7.5 keV, quadratically time-dependent energy shear. This beam will be injected into the existing 5-m long periodic transport channel with 38 short solenoid lenses. With the given beam parameters and initial conditions the pulse will be compressed by a factor of 4 to 5 before reaching the end of the existing solenoid channel. This paper reports on the design features and the measured general performance characteristics of the injector system including its mechanical, electrical, and beam-optical properties. DOE

**N91-17695#** Argonne National Lab., IL. Engineering Physics Div.

**APPLICATION OF RF SUPERCONDUCTIVITY TO HIGH-BRIGHTNESS ION-BEAM ACCELERATORS**

J. R. Delayen, C. L. Bohn, and C. T. Roche 1990 11 p Presented at the 11th International Conference on the Application of Accelerators in Research and Industry, Denton, TX, 5-8 Nov. 1990 Sponsored by Army Strategic Defense Command

(Contract W-31-109-eng-38)

(DE91-006481; CONF-901116-38) Avail: NTIS HC/MF A03

A development program is underway to apply RF superconductivity to the design of CW linear accelerators for high brightness ion beams. The key issues associated with this endeavor have been delineated in an earlier paper. Considerable progress was made both experimentally and theoretically to resolve a number of these issues. This progress is summarized. Current and future work is identified in the areas of accelerator technology and superconducting materials which will confront the remaining issues and/or provide added capability to the technology. DOE

# 74 OPTICS

Includes light phenomena; and optical devices.

For lasers see *36 Lasers and Masers.*

**N91-17696#** Department of the Navy, Washington, DC.

**OPTICAL FIBER REFRACTOMETER Patent Application**

Lloyd C. Bobb, inventor (to Navy) and Howard Krumboltz, inventor (to Navy) 3 Jan. 1990 23 p

(AD-D014619; US-PATENT-APPL-SN-460436; NAVY-CASE-70053) Avail: NTIS HC/MF A03 CSCL 14/2

The index of refraction of a liquid is measured using an optical fiber refractometer having a light transmitting optical fiber by immersing a portion of the optical fiber in the liquid and launching light into one end of the optical fiber at a selected non-zero launch angle with respect to the fiber axis. Light transmitted through the optical fiber is detected at the other end of the optical fiber and a determination is made of the index of refraction of the liquid in accordance with the detected light and the selected non-zero launch angle. By varying the launching angles of the light the

range of the refractometer is increased. The light transmitting optical fiber is provided with a region having at least one tapered portion for further increasing the range of the refractometer. The tapered portion of the optical fiber is disposed between a reflective end of the optical fiber and the light source for providing single-ended operation. GRA

**N91-17697** New South Wales Univ., Sydney (Australia).
**INTEGRATED OPTICS: ION EXCHANGE OPTICAL WAVEGUIDES Ph.D. Thesis**
Michael John Millington 1986 3 p
Avail: Issuing Activity

The production and analysis of integrated optical components are investigated. Areas covered include detailed descriptions of manufacturing techniques and procedures, the measurement of refractive index profiles, attenuation and various other performance characteristics of integrated optical components. Silver sodium ion exchange waveguides are discussed due to the convenience, cost effectiveness, and relatively good performance of this technique. Dissert. Abstr.

**N91-17698#** National Oceanic and Atmospheric Administration, Boulder, CO. Wave Propagation Lab.
**OPTICAL INNER-SCALE METER**
G. R. Ochs, J. K. Holler, and J. J. Wilson Sep. 1990 23 p
(Contract ASL-86-8004)
(PB90-268285; NOAA-TR-ERL-WPL-183) Avail: NTIS HC/MF A03 CSCL 20F

An optical instrument that measures the path-averaged value of the inner scale of refractive-index turbulence over a range of 2 to 30 mm, and is optimized for 150-m propagation path lengths is described. Operating procedures are also described, that include the description and use of an external calibrator. GRA

**N91-17699#** Arizona Univ., Tucson. Optical Sciences Center.
**X RAY OPTICS RESEARCH Final Report, 1 Oct. 1987 - 30 Apr. 1990**
Charles M. Falco 20 Sep. 1990 11 p
(Grant AF-AFOSR-0010-88; AF Proj. 2301)
(AD-A228940; AFOSR-90-1101TR) Avail: NTIS HC/MF A03 CSCL 20/2

The production is described of x ray optical elements for several wavelengths by sputtering. It describes the installation of a silicon/metals molecular beam epitaxy (MBE) apparatus and its use in an extensive study of multilayer mirrors based on molybdenum and silicon. Continuing work on several additional materials is described. Finally, studies of substrate and interfacial roughness, using a scanning tunneling microscope (STM) and a WYKO phase shifting interferometer, are presented. GRA

**N91-17700#** Sandia National Labs., Albuquerque, NM.
**X RAY REFLECTIVITY MEASUREMENTS OF SURFACE ROUGHNESS USING ENERGY DISPERSIVE DETECTION**
E. Chason and D. T. Warwick 1990 7 p Presented at the Fall Meeting of the Materials Research Society, Boston, MA, 24 Nov. - 1 Dec. 1990
(Contract DE-AC04-76DP-00789)
(DE91-004819; SAND-90-1787C; CONF-901105-32) Avail: NTIS HC/MF A02

A new technique is described for measuring x ray reflectivity using energy dispersive x ray detection. The benefits of this method are the use of a fixed scattering angle and parallel detection of all energies simultaneously. These advantages make the technique more readily useable with laboratory x ray sources and more compatible with growth chambers. Excellent agreement was found between the calculated Fresnel reflectivity and the reflectivity obtained from a smooth Ge (001) surface. Reflectivities obtained during 500 eV Xe ion bombardment of Ge surfaces demonstrate the sensitivity of the technique to be better than 1A. DOE

**N91-17701#** Brookhaven National Lab., Upton, NY.
**A STUDY OF ELECTRO-OPTICAL MODULATORS FOR TRANSFER OF DETECTOR SIGNALS BY OPTICAL FIBERS**
T. Tsang, V. Radeka, T. Srinivasan-Rao, and W. J. Willis (Columbia Univ., New York, NY.) Oct. 1990 7 p Presented at the Symposium on Detector Research and Development for the Superconducting Super Collider, Fort Worth, TX, 15-18 Oct. 1990
(Contract DE-AC02-76CH-00016)
(DE91-006349; BNL-45393; CONF-9010212-28) Avail: NTIS HC/MF A02

Preliminary results of an investigation to minimize the local electronics on the detector by the use of electro-optical intensity modulators are reported. The electrical signal from the detector is converted into an optical signal by a Mach-Zehnder interferometer modulator based on the properties of electro-optical crystals such as LiNbO3. The modulator is driven by the electrical signal from a detector element such as the gas proportional straw tube. The optical signal is brought in from a remote source and exits on an optical fiber to a data collection site. The results of the first tests of optical modulators with respect to their application to particle detectors will be presented. These include the optical power requirement, the linearity, the dynamic range, and the noise characteristics. Finally, the outlook for their application on a large scale is discussed. DOE

**N91-17702#** Georgia Univ., Athens. Dept. of Physics and Astronomy.
**OPTICAL STUDIES OF DYNAMICAL PROCESSES IN DISORDERED MATERIALS Progress Report**
William M. Yen Dec. 1990 10 p
(Contract DE-FG09-87ER-45291)
(DE91-006483; DOE/ER-45291/4) Avail: NTIS HC/MF A02

The research continues to focus on the study of the structure and the dynamic behavior of insulating solids which can be activated optically. The physical processes which produce relaxation and energy transfer in the optical excited states were of particular interest. The studies were based principally on optical laser spectroscopic techniques which reveal a more detailed view of the materials of interest and which will ultimately lead to the development of more efficient optoelectronic materials. DOE

# 75 PLASMA PHYSICS

Includes magnetohydrodynamics and plasma fusion.

For ionospheric plasmas see *46 Geophysics*. For space plasmas see *90 Astrophysics*.

**N91-17703#** Lodestar Research Corp., Boulder, CO.
**WORKSHOP ON HIGH POWER ICH ANTENNA DESIGNS FOR HIGH DENSITY TOKAMAKS**
R. E. Aamodt, ed. 21 Feb. 1990 7 p Workshop held in Boulder, CO, 31 Jan. - 2 Feb. 1990
(Contract DE-FG02-88ER-53263)
(DE90-010519; DOE/ER-53263/8; LRC-90-13; CONF-900169-2)
Avail: NTIS HC/MF A02

A workshop in high power ICH antenna designs for high density tokamaks was held to: (1) review the data base relevant to the high power heating of high density tokamaks; (2) identify the important issues which need to be addressed in order to ensure the success of the ICRF programs on CIT and Alcator C-MOD; and (3) recommend approaches for resolving the issues in a timely realistic manner. Some specific performance goals for the antenna system define a successful design effort. Simply stated these goals are: couple the specified power per antenna into the desired ion species; produce no more than an acceptable level of RF auxiliary power induced impurities; and have a mechanical structure which safely survives the thermal, mechanical and radiation stresses in the relevant environment. These goals are intimately coupled and difficult tradeoffs between scientific and engineering constraints have to be made. DOE

**N91-17704#** Sandia National Labs., Albuquerque, NM.
**MODELING OF RUNAWAY ELECTRON DAMAGE FOR THE DESIGN OF TOKAMAK PLASMA FACING COMPONENTS**
K. A. Niemer, J. G. Gilligan, C. D. Croessmann, and H. H. Bolt

(Max-Planck-Inst. fuer Plasmaphysik, Garching, Germany, F.R. ) Apr. 1990 22 p Presented at the 13th IEEE Symposium on Fusion Engineering, Knoxville, TN, 2-6 Oct. 1989
(Contract DE-AC04-76DP-00789)
(DE90-008237; SAND-89-2405; CONF-891007-119) Avail: NTIS HC/MF A03

Cracking, craters, spotty damage (discoloration), and missing chunks of material have been observed on limiters and along the midplane of tokamak inner walls. This damage is assumed to be due to runaway electron discharges. These runaway electrons have been predicted to range in energy from a few MeV to several hundred MeV. The energy density from the runaway electron discharges ranges from 10 to 500 MJ/sq m over pulse lengths of 5 to 50 msec. The PTA code package is a three dimensional, time dependent, computational code package used to predict energy deposition, temperature rise, and damage on tokamak first wall and limiter materials form runaway electron impact. Two experiments were modeled to validate the PTA code package. The first experiment tested the thermal and structural response from high energy electron impact on different fusion materials, and the second experiment simulated runaway electrons scattering through a plasma facing surface (graphite) into an internal structure (copper). The PTA calculations compared favorably with the experimental results. In particular, the PTA models identified gap conductance, thermal contact, x ray generation in materials, and the placement of high stopping power materials as key factors in the design of plasma facing components, resistant to runaway electron damage. DOE

**N91-17705#** Texas Univ., Austin. Fusion Research Center.
**PLASMA CONFINEMENT THEORY AND TRANSPORT SIMULATION Technical Progress Report, 1 Nov. 1989 - 31 Oct. 1990**
David W. Ross Apr. 1990 6 p
(Contract DE-FG05-88ER-53266)
(DE90-011072; DOE/ER-53266/32) Avail: NTIS HC/MF A02

The objectives are to advance the transport studies of tokamaks, including development and maintenance of the Magnetic Fusion Energy Database, and to provide theoretical interpretation and modeling for TEXT, and equilibrium and stability studies for TEXT-Upgrade. DOE

**N91-17706#** Oak Ridge National Lab., TN.
**THE INSULATION IRRADIATION TEST PROGRAM FOR THE COMPACT IGNITION TOKAMAK**
T. J. McManamy, G. Kanemoto, and P. Snook (Princeton Univ., NJ.) 1990 13 p Presented at the Nonmetallic Materials and Composites at Low Temperatures Conference, Heidelberg, Fed. Republic of Germany, 17-18 May 1990
(Contracts DE-AC05-84OR-21400; DE-AC07-76ID-01570)
(DE90-011318; CONF-900519-1) Avail: NTIS HC/MF A03

The electrical insulation for the toroidal field coils of the Compact Ignition Tokamak (CIT) is expected to be exposed to radiation doses on the order of 10(exp 10) rad with approximately 90 percent of the dose from neutrons. The coils are cooled to liquid nitrogen temperature and then heated during the pulse to a peak temperature of greater than 300 K. In a program to evaluate the effects of radiation exposure on the insulators, three types of boron-free insulation were irradiated at room temperature in the Advanced Technology Reactor (ATR) and tested at the Idaho National Engineering Laboratory. The materials were Spaulrad-S, Shikishima PG5-1, and Shikishima PG3-1. The first two use a bismaleimide resin and the third an aromatic amine hardened epoxy. Spaulrad-S is a two-dimensional (2-D) weave of S-glass, while the others are 3-D weaves of T-glass. Flexure and shear/compression samples were irradiated to approximately 5 x 10(exp 9) and 3 x 10(exp 10)rad with 35 to 40 percent of the total dose from neutrons. The shear/compression samples were tested in pairs by applying an average compression of 345 MPa and then a shear load. After static tests were completed, fatigue testing was done by cycling the shear load for up to 30,000 cycles with a constant compression. The static shear strength of the samples that did not fail was then determined. Generally, shear strengths on the order of 120 MPa were measured. The behavior of the flexure and shear/compression samples was significantly different; large reductions in the flexure strength were observed, while the shear strength stayed the same or increased slightly. The 3-D weave material demonstrated higher strength and significantly less radiation damage than the 2-D material in flexure but performed nearly identically when tested with combined shear and compression. The epoxy system was much more sensitive to fatigue damage than the bismaleimide materials. DOE

**N91-17707#** Oak Ridge National Lab., TN.
**ATF EDGE PLASMA TURBULENCE STUDIES USING A FAST RECIPROCATING LANGMUIR PROBE**
T. Uckan, C. Hidalgo, J. D. Bell, J. H. Harris, J. L. Dunlap, G. R. Dyer, P. K. Mioduszewski, J. B. Wilgen, C. P. Ritz, and A. J. Wootton (Texas Univ., Austin.) et al 1990 40 p Presented at the 9th Plasma Interaction Conference, Bournemouth, England, 20-25 May 1990
(Contracts DE-AC05-84OR-21400; DE-FG05-89ER-53295)
(DE90-011709; CONF-900505-3) Avail: NTIS HC/MF A03

Electrostatic turbulence on the edge of the Advanced Torodial Facility (ATF) torsatron is investigated experimentally with a fast reciprocating Langmuir probe (FRLP) array. Initial measurements of plasma electron density n(sub e) and temperature T(sub e) and fluctuations in density (tilde n(sub e)) and plasma floating potential (tilde phi(sub f)) are made in ECH plasmas at 1 T. At the last closed flux surface (LCFS, r/(bar a) approximately 1), T(sub e) approximately 20 to 40 eV and n(sub e) approximately 10(exp 12) cm(exp -3) for a line-averaged electron density (bar n)(sub e) = (3-6) x 10(exp 12) cm(exp -3). Relative fluctuation levels, as the FRLP is moved into core plasma where T(sub e) greater than 20 eV, are (tilde n)(sub e)/n(sub e) approximately 5 percent, and e (tilde phi)(sub f)/T(sub e) approximately 2(tilde n)(sub e)/n(sub e) about 2 cm inside the LCFS. The observed fluctuation spectra are broadband (40 to 300 kHz) with (bar k) rho(sub s) less than or equal to 0.1, where (bar k) is the wavenumber of the fluctuations and rho(sub s) is the ion Larmor radius at the sound speed. The propagation direction of the fluctuations reverses to the electron diamagnetic direction around r/(bar a) less than 1. The phase velocity and the electron drift velocity are comparable (v(sub ph) approximately v(sub de)). The fluctuation-induced particle flux is comparable to fluxes estimated from the particle balance using the H(sub alpha) spectroscopic measurements. Many of the features seen in these experiments resemble the features of ohmically heated plasmas in the Texas Experimental Tokamak (TEXT). DOE

**N91-17708#** National Inst. for Fusion Science, Nagoya (Japan).
**STRUCTURES IN CONFINED PLASMAS. PROCEEDINGS OF A WORKSHOP OF US-JAPAN JOINT INSTITUTE FOR FUSION THEORY PROGRAM**
Mar. 1990 238 p Workshop held at Nagoya, Japan, 13-16 Mar. 1989
(NIFS-PROC-2; ISSN-0915-6348) Avail: NTIS HC/MF A11

The specific topics of the workshop were the mechanisms by which self-organization into coherent structures through nonlinear interactions is achieved. The contributions to the workshop's proceedings are divided into seven sections: (1) vortex structures in two-fluid plasmas; (2) temperature gradient modes; (3) structures in one-fluid plasmas; (4) structures in Vlasov plasmas; (5) vortex structures in fluids; (6) hybrid code-particle electron and fluid ion; and (7) basic theories. Author

**N91-17709** Princeton Univ., NJ.
**THE COMPUTATION OF RESISTIVE MHD INSTABILITIES IN AXISYMMETRIC TOROIDAL PLASMAS Ph.D. Thesis**
Thomas Randall Harley 1990 152 p
Avail: Univ. Microfilms Order No. DA9026409

An optimal formulation of the resistive MHD stability eigenmode equations was developed for the purpose of computational studies. In order to accurately calculate resistive instabilities for resistivities in the range of fusion reactors, it is essential to overcome the problem of numerical errors caused by terms in the eigenmode

equations associated with the fast magnetosonic wave. This type of numerical error is referred to as spectral pollution. A specific formulation fo the linearized resistive MHD eigenmode equations was carefully chosen on the basis of minimizing the numerical error due to spectral pollution by accurately resolving the continuum spectrum of the ideal MHD operator. The effective technique used for eliminating spectral pollution is not limited to only working in the 1d cylindrical limit. The formulation reduces the resistive MHD stability equations into three second order coupled equations in a manner such that one of the three equations recovers the identical formulation of the NOVA code in the ideal limit. The nonvariational approach being used was already successfully applied to the linearized ideal MHD eigenmode equations in the NOVA code. Two stability codes were developed in order to implement the formulation. The NOVA-RC stability code solves the linearized resistive MHD eigenmode equations for 1d cylindrical equilibria. The NOVA-R stability code solves the linearized resistive MHD eigenmode equations for a given axisymmetric toroidal plasma equilibrium with noncircular flux surfaces. Results from both codes are presented in order to establish their credibility. The eigenfunctions are represented by a Fourier expansion and cubic B-spline finite elements. The full set of linearized resistive MHD equations are solved everywhere in the plasma, rather than using asymptotic matching between ideal and resistive regions.
Dissert. Abstr.

**N91-17710#** General Atomic Co., San Diego, CA.
**SPECTROSCOPIC STUDY OF EDGE POLOIDAL ROTATION AND RADIAL ELECTRIC FIELDS IN THE DIII-D TOKAMAK**
R. J. Groebner, K. H. Burrell, P. Gohil, and R. P. Seraydarian Oct. 1990 22 p Presented at the 8th Topical Conference on High-Temperature Plasma Diagnostics, Hyannis, MA, 7-10 May 1990 Submitted for publication
(Contract DE-AC03-89ER-51114; GA Proj. 3466)
(DE91-002706; GA-A-20100; CONF-900557-28) Avail: NTIS HC/MF A03

Doppler-shift spectroscopy has shown that finite values of poloidal rotation velocity (upsilon sub theta) and of radial electric field E sub r exist at the edge of a tokamak plasma and that dramatic increases occur in these parameters at an L-H transition. E sub r is negative in the L-mode and becomes more negative in the H-mode; upsilon sub theta increases in magnitude at the transition. In addition, the radial gradients (shear) of upsilon sub theta and E sub r are large and these gradients also increase at the L-H transition. These results are based on measurements of Doppler shifts of light emitted by He II ions, located in a region about 1 to 3 cm inside the separatrix. These observations were made with horizontally viewing and vertically viewing spectrometer systems on the DIII-D tokamak. The nearly orthogonal views of these systems are used to determine the plasma's flow velocity in terms of the orthogonal sets (upsilon sub theta) and (upsilon sub phi) or of (upsilon sub perpendicular) and (upsilon sub parallel). Knowledge of upsilon sub perpendicular) is used to calculate E sub r from the force balance equation for a single ion species. The existing results impose constraints on theories of the L-H transition. More detailed studies of the spatial profiles and temporal evolution of upsilon sub theta and E sub r will be made with upgraded instrumentation, which is now coming on-line. DOE

**N91-17711#** Air Force Systems Command, Wright-Patterson AFB, OH. Foreign Technology Div.
**FIELD EMISSION INITIATION MECHANISM OF VACUUM ARC**
G. N. Fursey 12 Jul. 1990 17 p Transl. into ENGLISH from Voprosy Elektroniki Tverdogo Tela (USSR), no. 336, 1968 p 120-126
(AD-A227560; FTD-ID(RS)T-0586-90) Avail: NTIS HC/MF A03 CSCL 20/9

The phenomenon of vacuum breakdown substantially limits the use of a different kind of high-voltage vacuum devices and instruments. To this problem is devoted the very large number of works. However, the mechanism of this phenomenon still remains poorly understood. The fundamental reasons for this are the probabalistic nature of the process of initiation, depending on the large number of factors, that determine real experimental conditions, and extremely short transit time to the high conductivity of gap/interval (10-8-10-9 s). In this connection special importance finds conducting experiment under strictly controlled/inspected conditions and formulation of problem for detection of those phenomena, which directly precede this transition/junction. GRA

**N91-17712#** Georgia Inst. of Tech., Atlanta. Fusion Research Center.
**PARTICLE TRANSPORT WITH ICRH AND ECRH IN TOKAMAKS**
K. Indireshkumar and W. M. Stacey Jul. 1990 81 p
(PB91-106005; GTFR-93) Avail: NTIS HC/MF A05 CSCL 20I

There are both theoretical and experimental indications that radio frequency heating can significantly affect particle transport. High power electron cyclotron resonance heating (ECRH) and ion cyclotron resonance heating (ICRH) can cause order epsilon poloidal variation in potential which could significantly alter the transport of non-resonant particles. Wave-particle interactions induce additional transport via modification of the perpendicular velocity, parallel velocity, and toroidal canonical angular momentum. Theoretical and experimental investigations are reviewed which provide information about the effects of ECRH and ICRH on particle transport. GRA

**N91-17713*#** National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
**CURRENT COLLECTION FROM SPACE PLASMAS**
Nagendra Singh, ed., K. H. Wright, Jr., ed. (Alabama Univ., Huntsville.), and Nobie H. Stone, ed. Washington Dec. 1990 368 p Workshop held in Huntsville, AL, 24-25 Apr. 1989; sponsored by NASA. Marshall Space Flight Center and Alabama Univ.
(NASA-CP-3089; M-644; NAS 1.55:3089) Avail: NTIS HC/MF A16 CSCL 20I

The First Workshop on Current Collection from Space Plasmas was held at the Tom Bevil Center on the campus of The University of Alabama in Huntsville on April 24 to 25, 1989. The intent of the workshop was to assemble experts on various topics related to the problem of current collection for deliberations that would elucidate the present understanding of the overall current collection problem. Papers presented at the workshop are presented. For individual titles, see N91-17714 through N91-17734.

**N91-17714*#** California Univ., San Diego, La Jolla. Center for Astrophysics and Space Science.
**CURRENT COLLECTION FROM AN UNMAGNETIZED PLASMA: A TUTORIAL**
Elden C. Whipple *In* NASA, Marshall Space Flight Center, Current Collection from Space Plasmas Dec. 1990 p 1-12
(For primary document see N91-17713 09-75)
(Grant NGL-05-005-007)
Avail: NTIS HC/MF A16 CSCL 20I

The current collected by a body in an unmagnetized plasma depends in general on: (1) the properties of the plasma; (2) the properties of the body; and (3) the properties of any neutral species that are present. The important plasma properties are the velocity distributions of the plasma particles at a location remote from the body (at infinity), and the Debye length which determines the importance of plasma space charge effects. The important body properties are its surface characteristics, namely the conductivity and secondary yield coefficients. The neutral species affect the current through collisions which impede the flow of current and possibly through ionization of the neutrals which can enhance the current. The technique for calculating the current collected by a body in a plasma is reviewed with special attention given to the distinction between orbit limited and space charge limited regimes, the asymptotic variation of the potential with distance from a body, and the concept of a sheath. Author

**N91-17715*#** York Univ. (Ontario). Dept. of Physics.
**CURRENT COLLECTION IN A MAGNETOPLASMA**
Jim G. Laframboise and L. J. Sonmor *In* NASA, Marshall Space

Flight Center, Current Collection from Space Plasmas Dec. 1990 p 13-49 Sponsored by Institute for Space and Terrestrial Science, York, Ontario (For primary document see N91-17713 09-75)
(Contracts F19628-85-K-0043; N60921-86-C-A226; NSERC-A-4638)
Avail: NTIS HC/MF A16 CSCL 20I

The authors present a survey of a very incomplete subject, current collection in a magnetoplasma. The best-developed and simplest theories for current collection are steady-state collisionless theories, and these must be understood before departures from them can be analyzed usefully. Thus, the authors begin with a review of them. The authors include some recent numerical results which indicate that steady-state collisionless Laplace-limit currents remain substantially below the Parker-Murphy (1967) canonical upper bound out to very large electrode potentials, and approach it as a limit only very slowly if at all. Attempts to correct this theory for space-charge effects lead to potential disturbances which extend to infinite distance along the electrode's magnetic shadow, unless collisional effects are also taken into account. However, even a small amount of relative plasma drift motion, such as that involved in a typical rocket experiment, can change this conclusion fundamentally. It is widely believed that time-averaged current collection may be increased by effects of plasma turbulence, and the authors review the available evidence for and against this contention. Steady-state collisionless particle dynamics predicts the existence of a toroidal region of trapped orbits which surrounds the electrode. Light emissions from this region have been photographed, indicating that collisional ionization may also occur there, and this, and/or scattering by collisions or possibly turbulent fluctuations in this region, may also increase current collection by the electrode. The authors also discuss effects on particle motions near the electrode, associated with breakdown of magnetic insulation in the region of large electric fields near it. Author

**N91-17716*#** Alabama Univ., Huntsville. Dept. of Electrical and Computer Engineering.
**CURRENT COLLECTION IN A FLOWING MAGNETOPLASMA**
Nagendra Singh and Bharat I. Vashi *In* NASA, Marshall Space Flight Center, Current Collection from Space Plasmas Dec. 1990 p 50-73 Sponsored in part by Cray Research, Inc. (For primary document see N91-17713 09-75)
(Grant NAGw-1562)
Avail: NTIS HC/MF A16 CSCL 20I

Effects of plasma drift on the current collection by a long conducting cylinder in a magnetized plasma is studied by means of a 2 1/2 dimensional PIC code. It is found that for the drift velocity (V sub 0) perpendicular to the magnetic field (B sub 0), the electron current collected by a positive cylinder is considerably enhanced depending on the drift velocity. The distributions of plasma and the potential structure around the cylinder for several relative orientations between V sub 0 and B are presented along with the comparisons of current with and without the magnetic field. Simulations with the magnetic field in the simulation plane show that the potential structures around the cylinder are two-dimensional double layers with dimension (L) perpendicular to B much smaller than the dimension (L) parallel to B. In fact, L perpendicular is found to be approximately determined by the current limiting radius given by the Parker-Murphy model. However, it is found that the collected currents in the simulations are generally higher than those given by this model. Author

**N91-17717*#** California Univ., San Diego, La Jolla. Center for Astrophysics and Space Sciences.
**CURRENT COLLECTION IN AN ANISOTROPIC PLASMA**
Wei-Wei Li *In* NASA, Marshall Space Flight Center, Current Collection from Space Plasmas Dec. 1990 p 74-87 (For primary document see N91-17713 09-75)
(Grant NGL-05-005-007)
Avail: NTIS HC/MF A16 CSCL 20I

A general method is given to derive the current-potential relations in anisotropic plasmas. Orbit limit current is assumed. The collector is a conductive sphere or an infinite cylinder. Any distribution which is an arbitrary function of the velocity vector can be considered as a superposition of many mono-energetic beams whose current-potential relations are known. The results for two typical pitch angle distributions are derived and discussed in detail. The general properties of the current potential relations are very similar to that of a Maxwellian plasma except for an effective temperature which varies with the angle between the magnetic field and the charging surface. The conclusions are meaningful to generalized geometries. Author

**N91-17718*#** Science Applications International Corp., McLean, VA. Lab. for Atmospheric and Space Sciences.
**MEASUREMENT REALITIES OF CURRENT COLLECTION IN DYNAMIC SPACE PLASMA ENVIRONMENTS**
Edward P. Szuszczewicz *In* NASA, Marshall Space Flight Center, Current Collection from Space Plasmas Dec. 1990 p 88-124 (For primary document see N91-17713 09-75)
Avail: NTIS HC/MF A16 CSCL 20I

Theories which describe currents collected by conducting and non-conducting bodies immersed in plasmas have many of their concepts based upon the fundamentals of sheath-potential distributions and charged-particle behavior in superimposed electric and magnetic fields. Those current-collecting bodies (or electrodes) may be Langmuir probes, electric field detectors, aperture plates on ion mass spectrometers and retarding potential analyzers, or spacecraft and their rigid and tethered appendages. Often the models are incomplete in representing the conditions under which the current-voltage characteristics of the electrode and its system are to be measured. In such cases, the experimenter must carefully take into account magnetic field effects and particle anisotropies, perturbations caused by the current collection process itself and contamination on electrode surfaces, the complexities of non-Maxwellian plasma distributions, and the temporal variability of the local plasma density, temperature, composition and fields. This set of variables is by no means all-inclusive, but it represents a collection of circumstances guaranteed to accompany experiments involving energetic particle beams, plasma discharges, chemical releases, wave injection and various events of controlled and uncontrolled spacecraft charging. Here, an attempt is made to synopsize these diagnostic challenges and frame them within a perspective that focuses on the physics under investigation and the requirements on the parameters to be measured. Examples include laboratory and spaceborne applications, with specific interest in dynamic and unstable plasma environments. Author

**N91-17719*#** California Univ., Los Angeles. Dept. of Physics.
**LABORATORY EXPERIMENTS ON CURRENT FLOW BETWEEN STATIONARY AND MOVING ELECTRODES IN MAGNETOPLASMAS**
Reiner L. Stenzel and J. M. Urrutia *In* NASA, Marshall Space Flight Center, Current Collection from Space Plasmas Dec. 1990 p 125-127 Sponsored in part by NSF and UERG (For primary document see N91-17713 09-75)
Avail: NTIS HC/MF A16 CSCL 20I

Laboratory experiments were performed in order to investigate the basic physics of current flow between tethered electrodes in magnetoplasmas. The major findings are summarized. The experiments are performed in an effectively very large laboratory plasma in which not only the nonlinear current collection is addressed but also the propagation and spread of currents, the formation of current wings by moving electrodes, the current closure, and radiation from transmission lines. The laboratory plasma consists of a pulsed dc discharge whose Maxwellian afterglow provides a quiescent, current-free uniform background plasma. Electrodes consisting of collectors and electron emitters are inserted into the plasma and a pulsed voltage is applied between two floating electrodes via insulated transmission lines. Besides the applied current in the wire, the total current density in the plasma is obtained from space and time resolved magnetic probe measurements via Maxwell's law. Langmuir probes yield the plasma parameters. Author

**N91-17720*#** Colorado State Univ., Fort Collins. Dept. of Mechanical Engineering.
**LABORATORY EXPERIMENTS ON PLASMA CONTACTORS**
Paul J. Wilbur and John D. Williams *In* NASA, Marshall Space Flight Center, Current Collection from Space Plasmas Dec. 1990 p 128-149 (For primary document see N91-17713 09-75)
(Grant NAG3-776)
Avail: NTIS HC/MF A16 CSCL 20I

Experimental results describing the operation of hollow cathode plasma contactors collecting and emitting electrons from and to an ambient plasma at current levels of the order of one ampere are presented. The voltage drops induced between a contactor and an ambient plasma are shown to be a few tens of volts at such current levels. The development of a double sheath and the production of substantial numbers of ions by electrons streaming across it are associated with the electron collection process. The development of a complex potential structure including a high potential hill just downstream of the cathode orifice is shown to characterize typical contactor emitting electrons. Author

**N91-17721*#** Massachusetts Inst. of Tech., Cambridge. Plasma Fusion Center.
**THEORY OF PLASMA CONTACTORS IN GROUND-BASED EXPERIMENTS AND LOW EARTH ORBIT**
M. J. Gerver, Daniel E. Hastings, and M. R. Oberhardt (Air Force Geophysics Lab., Hanscom AFB, MA.) *In* NASA, Marshall Space Flight Center, Current Collection from Space Plasmas Dec. 1990 p 150-189 (For primary document see N91-17713 09-75)
Avail: NTIS HC/MF A16 CSCL 20I

Previous theoretical work on plasma contactors as current collectors has fallen into two categories: collisionless double layer theory (describing space charge limited contactor clouds) and collisional quasineutral theory. Ground based experiments at low current are well explained by double layer theory, but this theory does not scale well to power generation by electrodynamic tethers in space, since very high anode potentials are needed to draw a substantial ambient electron current across the magnetic field in the absence of collisions (or effective collisions due to turbulence). Isotropic quasineutral models of contactor clouds, extending over a region where the effective collision frequency upsilon sub e exceeds the electron cyclotron frequency omega sub ce, have low anode potentials, but would collect very little ambient electron current, much less than the emitted ion current. A new model is presented, for an anisotropic contactor cloud oriented along the magnetic field, with upsilon sub e less than omega sub ce. The electron motion along the magnetic field is nearly collisionless, forming double layers in that direction, while across the magnetic field the electrons diffuse collisionally and the potential profile is determined by quasineutrality. Using a simplified expression for upsilon sub e due to ion acoustic turbulence, an analytic solution has been found for this model, which should be applicable to current collection in space. The anode potential is low and the collected ambient electron current can be several times the emitted ion current. Author

**N91-17722*#** Systems Science and Software, La Jolla, CA.
**PHYSICAL PROCESSES ASSOCIATED WITH CURRENT COLLECTION BY PLASMA CONTACTORS**
Ira Katz and Victoria A. Davis *In* NASA, Marshall Space Flight Center, Current Collection from Space Plasmas Dec. 1990 p 190-200 (For primary document see N91-17713 09-75)
(Contract NAS3-23881)
Avail: NTIS HC/MF A16 CSCL 20I

Recent flight data confirms laboratory observations that the release of neutral gas increases plasma sheath currents. Plasma contactors are devices which release a partially ionized gas in order to enhance the current flow between a spacecraft and the space plasma. Ionization of the expellant gas and the formation of a double layer between the anode plasma and the space plasma are the dominant physical processes. A theory is presented of the interaction between the contactor plasma and the background plasma. The conditions for formation of a double layer between the two plasmas are derived. Double layer formation is shown to be a consequence of the nonlinear response of the plasmas to changes in potential. Numerical calculations based upon this model are compared with laboratory measurements of current collection by hollow cathode-based plasma contactors. Author

**N91-17723*#** Air Force Geophysics Lab., Hanscom AFB, MA.
**DOUBLE LAYERS IN CONTACTOR PLASMAS Abstract Only**
David L. Cooke *In* NASA, Marshall Space Flight Center, Current Collection from Space Plasmas Dec. 1990 p 201 (For primary document see N91-17713 09-75)
Avail: NTIS HC/MF A16 CSCL 20I

The concept of using a hollow cathode to establish a low impedance contact between a spacecraft and the ambient plasma continues to gain in popularity, and is often then referred to as a plasma contactor. A growing number of studies indicate that large contact currents can be supported with small potential difference between the contactor and the ambient plasma. Results will be presented from a simple one-dimensional spherical model that obtains potentials from the solution of Poisson's equation, and particle densities from a turning point formalism that includes particle angular momentum. The neglect of collisions and magnetic field limits the realism. However, the results illustrate the effect of double layers that can form at the interface between contactor and ambient plasmas, when there is any voltage differential between the contactor and the ambient. The I-V characteristic of this model shows the usual space charge depends upon collection when the contactor flux is lower than some threshold; independence of I from variation in V when the flux is slightly greater than that threshold, and (numerical ?) instability for excessive flux suggesting the possibility of negative resistance. Even if a real I-V characteristic does not exhibit negative resistance, flat spots or high resistance regions may still be troublesome (or useful) to the total circuit. Author

**N91-17724*#** Maryland Univ., College Park.
**CURRENT COLLECTION BY HIGH VOLTAGE ANODES IN NEAR IONOSPHERIC CONDITIONS**
John A. Antoniades, Rod G. Greaves, D. A. Boyd, and R. Ellis *In* NASA, Marshall Space Flight Center, Current Collection from Space Plasmas Dec. 1990 p 202-213 Sponsored in part by ONR (For primary document see N91-17713 09-75)
Avail: NTIS HC/MF A16 CSCL 20I

The authors experimentally identified three distinct regimes with large differences in current collection in the presence of neutrals and weak magnetic fields. In magnetic field/anode voltage space the three regions are separated by very sharp transition boundaries. The authors performed a series of laboratory experiments to study the dependence of the region boundaries on several parameters, such as the ambient neutral density, plasma density, magnetic field strength, applied anode voltage, voltage pulsewidth, chamber material, chamber size and anode radius. The three observed regimes are: classical magnetic field limited collection; stable medium current toroidal discharge; and large scale, high current space glow discharge. There is as much as several orders of magnitude of difference in the amount of collected current upon any boundary crossing, particularly if one enters the space glow regime. They measured some of the properties of the plasma generated by the breakdown that is present in regimes II and III in the vicinity of the anode including the sheath modified electrostatic potential, I-V characteristics at high voltage as well as the local plasma density. Author

**N91-17725*#** Utah State Univ., Logan. Center for Atmospheric and Space Science.
**SPEAR-1: AN EXPERIMENT TO MEASURE CURRENT COLLECTION IN THE IONOSPHERE BY HIGH VOLTAGE BIASED CONDUCTORS**
W. John Raitt, Neil B. Myers, Jon A. Roberts, and D. C. Thompson *In* NASA, Marshall Space Flight Center, Current Collection from Space Plasmas Dec. 1990 p 214-231 (For

primary document see N91-17713 09-75)
(Contract DNA001-87-C-0015)
Avail: NTIS HC/MF A16 CSCL 20I

An experiment is described in which a high electrical potential difference, up to 45 kV, was applied between deployed conducting spheres and a sounding rocket in the ionosphere. Measurements were made of the applied voltage and the resulting currents for each of 24 applications of different high potentials. In addition, diagnostic measurements of optical emissions in the vicinity of the spheres, energetic particle flow to the sounding rocket, dc electric field and wave data were made. The ambient plasma and neutral environments were measured by a Langmuir probe and a cold cathode neutral ionization gauge, respectively. The payload is described and examples of the measured current and voltage characteristics are presented. The characteristics of the measured currents are discussed in terms of the diagnostic measurements and the in-situ measurements of the vehicle environment. In general, it was found that the currents observed were at a level typical of magnetically limited currents from the ionospheric plasma for potentials less than 12 kV, and slightly higher for larger potentials. However, due to the failure to expose the plasma contactor, the vehicle sheath modified the sphere sheaths and made comparisons with the analytic models of Langmuir-Blodgett and Parker-Murphy less meaningful. Examples of localized enhancements of ambient gas density resulting from the operation of the attitude control system thrusters (cold nitrogen) were obtained. Current measurements and optical data indicated localized discharges due to enhanced gas density that reduced the vehicle-ionosphere impedance. Author

**N91-17726*#** Naval Research Lab., Washington, DC. Plasma Physics Div.

**CURRENT COLLECTION BY A SPHERICAL HIGH VOLTAGE PROBE: ELECTRON TRAPPING AND COLLECTIVE PROCESSES Abstract Only**

Peter J. Palmadesso *In* NASA, Marshall Space Flight Center, Current Collection from Space Plasmas Dec. 1990 p 232 Sponsored in part by DNA (For primary document see N91-17713 09-75)
Avail: NTIS HC/MF A16 CSCL 20I

The author summarizes the results of theoretical studies of the interaction of an uninsulated, spherical, high voltage (10's of KV positive) probe with the ionospheric environment. The focus of this effort was the phenomenon of electron trapping and its implications for breakdown processes (collisional regime) and the current-voltage relationship governing current collection (collisionless regime) in space-based pulsed power systems with high voltage components exposed to space, e.g., the SPEAR I experiment. Author

**N91-17727*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.

**OBSERVATIONS OF THERMAL ION INFLUXES ABOUT THE SPACE SHUTTLE**

Joe M. Grebowsky and A. Schaefer (Marquette Univ., Milwaukee, WI.) *In* NASA, Marshall Space Flight Center, Current Collection from Space Plasmas Dec. 1990 p 233-255 (For primary document see N91-17713 09-75)
Avail: NTIS HC/MF A16 CSCL 20I

Ion mass spectrometer measurements made as part of the University of Iowa's Plasma Diagnostic Package on the STS-3 and Spacelab 2 Space Shuttle missions sampled a variety of ion composition and collected ion current responses to gas emissions from the vehicle. The only other shuttle ion measurements were made by an Air Force Geophysics Laboratory (AFGL) quadrupole spectrometer flown on STS-4. Gas emissions change the distribution of the incoming plasma through scattering and charge transfer processes. A background flux of contaminant ion species (mostly relating to water) always exists in the near vicinity of the shuttle with a magnitude which is dependent on the look direction of the spectrometer but which varies differently with changes in the angle of attack than that of the ambient ions. There is a near shuttle wake cavity in the contaminant ion distributions which has a different spatial configuration than the wake of the ambient ions. Although water dumps produce the most persistent ion perturbations, the sources for ion current modification were best delineated from measurements made when only one or two of the Reaction Control System thrusters fired for a relatively long duration. Contaminant ion perturbations associated with such firings were observed to persist for the order of a second after the cessation of the firings. The dense thruster plumes are efficient collisional, charge exchange barriers to the passage of ambient ions. Collected ion current perturbations were more evident for firings of the rear verniers, whose plumes scatter off projecting surfaces, than for the nose thrusters. The effect of the Vernier firings was found to depend not only on the location and attitude of the spectrometer with respect to the shuttle and thruster plume direction, but also on the orientation of the local magnetic field with respect to the shuttle velocity. Author

**N91-17728*#** Iowa Univ., Iowa City. Dept. of Physics and Astronomy.

**INTERACTION OF A NEUTRAL CLOUD MOVING THROUGH A MAGNETIZED PLASMA**

C. K. Goertz and G. Lu *In* NASA, Marshall Space Flight Center, Current Collection from Space Plasmas Dec. 1990 p 256-275 Sponsored in part by Lockheed Aircraft Corp. (For primary document see N91-17713 09-75)
(Grants NsG-7632; NSF ATM-84-11311)
Avail: NTIS HC/MF A16 CSCL 20I

Current collection by outgassing probes in motion relative to a magnetized plasma may be significantly affected by plasma processes that cause electron heating and cross field transport. Simulations of a neutral gas cloud moving across a static magnetic field are discussed. The authors treat a low-Beta plasma and use a 2-1/2 D electrostatic code linked with the authors' Plasma and Neutral Interaction Code (PANIC). This study emphasizes the understanding of the interface between the neutral gas cloud and the surrounding plasma where electrons are heated and can diffuse across field lines. When ionization or charge exchange collisions occur a sheath-like structure is formed at the surface of the neutral gas. In that region the crossfield component of the electric field causes the electron to E times B drift with a velocity of the order of the neutral gas velocity times the square root of the ion to electron mass ratio. In addition a diamagnetic drift of the electron occurs due to the number density and temperature inhomogeneity in the front. These drift currents excite the lower-hybrid waves with the wave k-vectors almost perpendicular to the neutral flow and magnetic field again resulting in electron heating. The thermal electron current is significantly enhanced due to this heating.
Author

**N91-17729*#** Naval Postgraduate School, Monterey, CA. Dept. of Physics.

**CURRENT LIMITING MECHANISMS IN ELECTRON AND ION BEAM EXPERIMENTS**

R. C. Olsen *In* NASA, Marshall Space Flight Center, Current Collection from Space Plasmas Dec. 1990 p 276-304 Sponsored by NASA, Lewis Research Center (For primary document see N91-17713 09-75)
Avail: NTIS HC/MF A16 CSCL 20I

The emission and collection of current from satellites or rockets in the ionosphere is a process which, at equilibrium, requires a balance between inward and outward currents. In most active experiments in the ionosphere and magnetosphere, the emitted current exceeds the integrated thermal current by one or more orders of magnitude. The system response is typically for the emitted current to be limited by processes such as differential charging of insulating surfaces, interactions between an emitted beam and the local plasma, and interactions between the beam and local neutral gas. These current limiting mechanisms have been illustrated for 20 years in sounding rocket and satellite experiments, which are reviewed here. Detailed presentations of the Spacecraft Charging at High Altitude (SCATHA) electron and ion gun experiments are used to demonstrate the general range of observed phenomena. Author

**N91-17730*#** Stanford Univ., CA. STAR Lab.
**EFFECTS OF NEUTRAL GAS RELEASE ON CURRENT COLLECTION DURING THE CHARGE-2 ROCKET EXPERIMENT**
B. E. Gilchrist, P. M. Banks, T. Neubert, P. R. Williamson, Neil B. Myers, W. John Raitt, and S. Sasaki (Tokyo Univ., Japan ) *In* NASA, Marshall Space Flight Center, Current Collection from Space Plasmas Dec. 1990 p 305-307 Sponsored in part by AFGL (For primary document see N91-17713 09-75)
(Grant NAGw-1566)
Avail: NTIS HC/MF A16 CSCL 20I

Observations of current collection enhancements due to cold nitrogen gas control jet emissions from a highly charged rocket payload in the ionosphere are reported. These observations were made during the second cooperative high altitude rocket gun experiment (CHARGE-2) which was an electrically tethered mother/daughter payload system. The current collection enhancement was observed at the daughter payload located 100 to 400 m away from the mother which was firing an energetic electron beam. The authors interpret these results in terms of an electrical discharge forming in close proximity to the daughter during the short periods of gas emission. The results indicate that it is possible to enhance the electron current collection capability of positively charged vehicles by means of deliberate neutral gas releases into an otherwise undisturbed space plasma. These results can also be compared with recent laboratory observations of hollow cathode plasma contactors operating in the ignited mode. Experimental observations of current collection enhancements due to cold nitrogen gas control jet emissions from a highly charged, isolated daughter payload in the nighttime ionosphere were made. These observations were derived from the second cooperative high altitude rocket gun experiment (CHARGE-2) which was an electrically tethered mother-daughter payload system. The rocket flew from White Sands Missile Range (WSMR) in December, 1985. The rocket achieved an altitude of 261 km and carried a 1 keV electron beam emitting up to 48 mA of current (Myers, et al., 1989a). The mother payload, carried the electron beam source, while the daughter acted as a remote current collection and observation platform and reached a distance of 426 m away from the main payload. Gas emissions at the daughter were due to periodic thruster jet firings to maintain separation velocity between the two payloads. Author

**N91-17731*#** Colorado Univ., Boulder. Dept. of Astrophysical, Planetary, and Atmospheric Sciences.
**EFFECTS OF NEUTRAL GAS RELEASES ON ELECTRON BEAM INJECTION FROM ELECTRICALLY TETHERED SPACECRAFT**
R. M. Winglee *In* NASA, Marshall Space Flight Center, Current Collection from Space Plasmas Dec. 1990 p 308-319 (For primary document see N91-17713 09-75)
(Grants NAGw-1587; NAGw-91; NsG-7827; NSF ATM-87-19371)
Avail: NTIS HC/MF A16 CSCL 20I

The presence of high neutral densities at low altitudes and/or during thruster firings is known to modify the spacecraft potential during active electron beam injection. Two-dimensional (three velocity) particle simulations are used to investigate the ionization processes including the neutral density required, the modification of the spacecraft potential, beam profile and spatial distribution of the return current into the spacecraft. Three processes are identified: (1) beam-induced ionization, (2) vehicle-induced ionization, and (3) beam plasma discharge. Only in the first two cases does the beam propagate away with little distortion. Author

**N91-17732*#** Alabama Univ., Huntsville. Dept. of Mechanical Engineering.
**PRESSURE AND CURRENT BALANCE CONDITIONS DURING ELECTRON BEAM INJECTIONS FROM SPACECRAFT**
K. S. Hwang and Nagendra Singh *In* NASA, Marshall Space Flight Center, Current Collection from Space Plasmas Dec. 1990 p 320-333 (For primary document see N91-17713 09-75)
(Contract NAS8-37107)
Avail: NTIS HC/MF A16 CSCL 20I

Electrostatic charging level of a conducting surface in response to injections of electron beams into space plasma is investigated by means of one-dimensional Vlasov code. Injections of Maxwellian beams into a vacuum shows that the surface can charge up to an electric potential phi sub s greater than W sub b, where W sub b is the average electron beam energy. Since Maxwellian beams have extended trails with electrons having energies greater than W sub b, it is difficult to quantify the charging level in terms of the energies of the injected electrons. In order to quantitatively understand the charging in excess of W sub b, simulations were carried out for water-bag types of beam with velocity distribution functions described by f(V) = A for V sub min approx. less than V approx. less than V sub max and f(V) = O otherwise, where A is a constant making the normalized beam density unity. It is found that V sub max does not directly determine the charging level. The pressure distribution in the electron sheath determines the electric field distribution near the surface. The electric field in turn determines the electrostatic potential of the vehicle. The pressure distribution is determined by the beam parameters such as the average beam velocity and the velocity spread of the beam. Author

**N91-17733*#** Systems Science and Software, La Jolla, CA.
**NASCAP/LEO CALCULATIONS OF CURRENT COLLECTION**
Myron J. Mandell, Ira Katz, Victoria A. Davis, and Robert A. Kuharski *In* NASA, Marshall Space Flight Center, Current Collection from Space Plasmas Dec. 1990 p 334-351 (For primary document see N91-17713 09-75)
(Contract NAS3-23881)
Avail: NTIS HC/MF A16 CSCL 20I

NASCAP/LEO is a 3-dimensional computer code for calculating the interaction of a high-voltage spacecraft with the cold dense plasma found in Low Earth Orbit. Although based on a cubic grid structure, NASCAP/LEO accepts object definition input from standard computer aided design (CAD) programs so that a model may be correctly proportioned and important features resolved. The potential around the model is calculated by solving the finite element formulation of Poisson's equation with an analytic space charge function. Five previously published NASCAP/LEO calculations for three ground test experiments and two space flight experiments are presented. The three ground test experiments are a large simulated panel, a simulated pinhole, and a 2-slit experiment with overlapping sheaths. The two space flight experiments are a solar panel biased up to 1000 volts, and a rocket-mounted sphere biased up to 46 kilovolts. In all cases, the authors find good agreement between calculation and measurement. Author

**N91-17734*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
**THE ENVIRONMENT POWER SYSTEM ANALYSIS TOOL DEVELOPMENT PROGRAM**
Gary A. Jongeward, Robert A. Kuharski, Eric M. Kennedy, N. John Stevens, Rand M. Putnam, James C. Roche, and Katherine G. Wilcox (Systems Science and Software, La Jolla, CA.) *In* NASA, Marshall Space Flight Center, Current Collection from Space Plasmas Dec. 1990 p 352-357 (For primary document see N91-17713 09-75)
Avail: NTIS HC/MF A16 CSCL 20I

The Environment Power System Analysis Tool (EPSAT) is being developed to provide space power system design engineers with an analysis tool for determining system performance of power systems in both naturally occurring and self-induced environments. The program is producing an easy to use computer aided engineering (CAE) tool general enough to provide a vehicle for technology transfer from space scientists and engineers to power system design engineers. The results of the project after two years of a three year development program are given. The EPSAT approach separates the CAE tool into three distinct functional

units: a modern user interface to present information, a data dictionary interpreter to coordinate analysis; and a data base for storing system designs and results of analysis. Author

**N91-17735#** Wisconsin Univ., Madison. Plasma Physics Research.
**GLOBAL CONFINEMENT IN THE MST (MADISON SYMMETRIC TORUS) REVERSED FIELD PINCH**
A. Almagri, S. Assadi, J. Beckstead, G. Chartas, M. Cudzinovic, D. DenHartog, R. Dexter, S. Hokin, D. Holly, and S. Prager et al Oct. 1990 16 p Presented at the Workshop on Physics of Alternative Magnetic Confinement Schemes, Varenna, Italy, 14-15 Oct. 1990 Prepared in cooperation with Pennsylvania State Univ., University Park; and Los Alamos National Lab., NM
(Contract DE-FG02-85ER-53198)
(DE91-004921; DOE/ER-53198/165; CONF-9010209-7) Avail: NTIS HC/MF A03

Global confinement measured in the first six months of MST full design operation is summarized. Central electron temperature and enhancement of resistivity over the Z = 1 Spitzer value are similar to other RFP experiments for the same value of I/N. As in several other RFP experiments, energy confinement time and poloidal beta are found to decrease with increasing plasma current, with maximum values of tau(sub E) approximately 1 ms and beta(sub p) approximately 10 percent. Particle transport may be approximated with a diffusion coefficient D approximately 40 sq m/s for a discharge studied with a 1-d particle/neutral code. A more elaborate code, incorporating heat and impurity transport, indicates an increase of Z(sub eff) with I/N. This code also reveals that the toroidal magnetic field decays resistively between discrete dynamo events, at the rate given by the measured global resistivity. Edge suprathermal electrons are observed as on other RFPs, with temperatures comparable to the central electron temperature and carrying a current density at least 15 percent of the total measured with an insertable magnetic coil array. Radial magnetic profiles measured with this array may be matched with a Modified Polynomial Function Model equilibrium for a value of beta(sub p) which is a factor of two larger than measured, but which is required due to the large values of Theta for a given F found in MST discharges (Theta = 1.85 at F = -0.15). DOE

**N91-17736#** Lawrence Livermore National Lab., CA.
**GRAZING INCIDENCE METAL MIRRORS AS THE FINAL ELEMENTS IN A LASER DRIVER FOR INERTIAL CONFINEMENT FUSION**
Robert L. Bieri and Michael W. Guinan 19 Nov. 1990 6 p Presented at the 9th Topical Meeting on Technology of Fusion Energy, Oak Brook, IL, 7-11 Oct. 1990
(Contract W-7405-eng-48)
(DE91-005272; UCRL-JC-103817-REV-1; CONF-901007-9-REV-1) Avail: NTIS HC/MF A02

Grazing incidence metal mirrors (GIMM's) were examined to replace dielectric mirrors for the final elements in a laser beam line for an inertial confinement fusion reactor. For a laser driver with a wavelength from 250 to 500 nm in a 10 ns pulse, irradiated mirrors made of Al, Al alloys, or Mg were found to have calculated laser damage limits of 0.3 to 2.3 J/sq cm of beam energy and neutron lifetime fluence limits of over 5 x 10(exp 20) 14 MeV n/sq cm (or 2.4 full power years when used in a 1000-MW reactor) when used at grazing incidence (an angle of incidence of 85 degrees) and operated at room temperature or at 77 K. A final focusing system including mirrors made of Al alloy 7457 at room temperature or at liquid nitrogen temperatures used with a driver which delivers 5 MJ of beam energy in 32 beams would require 32 mirrors of roughly 10 sq m each. This paper briefly reviews the methods used in calculating the damage limits for GIMMs and discusses critical issues relevant to the integrity and lifetime of such mirrors in a reactor environment. DOE

**N91-17737#** National Inst. of Standards and Technology, Boulder, CO.
**MATERIALS STUDIES FOR MAGNETIC FUSION ENERGY APPLICATIONS AT LOW TEMPERATURES-13**
R. L. Tobler and Richard Palmer Reed Sep. 1990 382 p Sponsored in part by DOE
(PB91-107086; NISTIR-3944) Avail: NTIS HC/MF A17 CSCL 20I

The results of research are presented to determine the properties of materials that may be used in cryogenic structures for the superconducting magnets of fusion energy power plants and prototypes. Research results for 1989 to 1990 are presented in four main program areas: (1) structural alloys; (2) welding; (3) test standards; and (4) technology transfer. Objectives and research highlights are also summarized. Author

**N91-17738#** Mission Research Corp., Newington, VA.
**THE DIMEX EXPERIMENT Final Report, 1 Aug. 1989 - 31 Jul. 1990**
John Brandenburg, W. Michael Bollen, Robert Seeley, and Khanh Nguyen 25 Sep. 1990 68 p
(Contract F49620-89-C-0106; AF Proj. 2301)
(AD-A229080; MRC/WDC-R-230; AFOSR-90-1075TR) Avail: NTIS HC/MF A04 CSCL 20/9

The DIpole plasma Microwave EXposure (DIMEX) experiment has demonstrated both stable confinement of plasma at electron densities of the order of 10 to the 11th power and electron temperatures of 1 eV and also has demonstrated strong absorption of 1 GHz microwaves with much reduced reflection (-10dB). In addition, high-intensity microwaves (greater than 0.1 W/sq cm) were strongly reflected, indicating that the plasma shell can function as a cloak to radar and a shield to HPM. It is believed that the successful demonstration of plasma confinement, cloaking to low-intensity microwaves, and even shielding to high-intensity microwaves can be explained in terms of exiting theory, drawn from the magnetic and laser fusion communities. GRA

**N91-17739#** Princeton Univ., NJ. Plasma Physics Lab.
**CIRCULAR LIMITER H-MODE PLASMAS IN THE TOKAMAK FUSION TEST REACTOR (TFTR)**
Charles E. Bush 1990 13 p Presented at the 2d Edward Bouchet International Conference on Physics and Technology, Accra, Ghana, 14-17 Aug. 1990
(Contract DE-AC02-76CH-03073)
(DE91-005850; CONF-9008171-2) Avail: NTIS HC/MF A03

Circular limiter H-modes with centrally peaked density profiles have been obtained in TFTR using a highly conditioned graphite limiter. The transition to these centrally peaked H-modes takes place from the supershot to the H-mode rather than the usual L- to H-mode transition observed in other tokamaks. Bidirectional beam heating is required and the threshold power needed to induce the transition increases linearly with plasma current. Density peaking factors, n(sub e)(0)/(n sub e), greater than 2.3 are obtained and, at the same time, the H-mode characteristics are similar to those of limiter H-modes on other tokamaks and the global confinement, tau(sub E), can be greater than 2.5 times L-mode scaling. Microwave scattering data from the edge plasma shows broad spectra at k = 5.5/cm which begin at the drop in D(sub alpha) radiation and are strongly shifted in the electron diamagnetic drift direction. This implies a poloidal rotation, which begins at the transition to the H-mode, of approximately 10(exp 4) m/sec. During an edge localized mode instability (ELM), these apparent rotations cease and Mirnov fluctuations in the 50 to 500 kHz range increase in intensity. Electron cyclotron emission data shows the origin of the ELMs and probably the transition layer to be located a few centimeters inside the plasma surface. A short review of requirements for controlled thermonuclear reactions is given in the introduction. DOE

**N91-17740#** Oak Ridge National Lab., TN.
**CRITICAL TOPICS OF PLASMA FACING MATERIALS/PLASMA FACING COMPONENT DATA FOR THE NEXT STEP FUSION DEVICES Foreign Trip Report**
Timothy D. Burchell Jan. 1991 13 p
(Contract DE-AC05-84OR-21400)
(DE91-005987; ORNL/FTR-3853) Avail: NTIS HC/MF A03

The United States-Japan Workshop P-165 brought together

approximately 60 scientists and engineers to discuss critical topics of plasma facing materials and components for the next-step fusion device. In addition to the United States and Japanese participants, there were several guest attendees from Europe. The international makeup of the participants greatly enhanced the success of the workshop. The author jointly chaired a workshop session entitled, Impact of Neutron Effects to Plasma Facing Materials and Plasma Facing Component (PFC) Feasibilities for the International Thermonuclear Experimental Reactor (ITER), and presented an overview paper on neutron effects and materials selection for the next-step plasma facing devices. The author presented his work on the effects of neutron irradiation on graphites and carbon-carbon (c/c) composite materials, which are strong candidate materials for PFC's in ITER. The workshop addressed many issues of current concern to the PFC/PFM community including: plasma erosion of PFM's; trapping/detrapping of hydrogen isotopes; large machine operating experience; and extent of the materials database.

DOE

**N91-17741#** Idaho National Engineering Lab., Idaho Falls.
**OCCURRENCE OF TUNGSTEN PLASMA IN PLASMA SPRAYING OF WC/Co**

B. A. Detering, J. R. Knibloe, and T. L. Eddy 1990 5 p Presented at the 3rd National Thermal Spray Conference and Exposition, Long Beach, CA, 21-25 May 1990
(Contracts DE-AC07-76ID-01570; BM-J0134035)
(DE91-006111; EGG-M-90317; CONF-900520-3) Avail: NTIS HC/MF A01

The conditions under which tungsten is vaporized and ionized during plasma spraying of WC/Co powders are investigated spectroscopically. Overheating of the powder results in less cobalt and decarburization of WC in the sprayed coating. The plasma is dominated by ionized tungsten and the resulting coating has a substantial amount of tungsten metal. DOE

**N91-17742#** Idaho National Engineering Lab., Idaho Falls.
**LTE (LOCAL THERMODYNAMIC EQUILIBRIUM) AND NON-LTE GAS TEMPERATURES IN LOADED AND UNLOADED PLASMAS DURING SPRAYING OF NiAl POWDERS**

T. L. Eddy, B. A. Detering, and G. C. Wilson 1990 6 p Presented at the 3th National Thermal Spray Conference and Exposition, Long Beach, CA, 21-25 May 1990
(Contracts DE-AC07-76ID-01570; BM-J0134035)
(DE91-006127; EGG-M-89428; CONF-900520-2) Avail: NTIS HC/MF A02

The purpose of this research is to contribute to the science of the complex particle plasma interaction in the plasma spray process. The relationship between the chaotic torch, the nonequilibrium plasma, the accelerating vaporizing particle, and the particle substrate interaction must be understood to relate coating characteristics to process parameters. This will lead to improved models, scalability, and appropriate monitoring and control of the process. This work focuses on the nonequilibrium plasma plume through which the particles must pass. Present models are based on the best knowledge available, but do not predict particle size, velocity, and surface temperatures that are consistent with experiments. Plasmas at pressures at and below atmospheric have been shown to deviate from local thermodynamic equilibrium (LTE). DOE

**N91-17743#** Idaho National Engineering Lab., Idaho Falls.
**BEHAVIOR OF ALUMINA PARTICLES IN ATMOSPHERIC PRESSURE PLASMA JETS**

J. R. Fincke and W. D. Swank 1990 6 p Presented at the Spring Meeting of the Materials Research Society, San Francisco, CA, 16-21 Apr. 1990
(Contract DE-AC07-76ID-01570)
(DE91-006147; EGG-M-89486; CONF-900466-97) Avail: NTIS HC/MF A02

The distribution of Al2O3 particle size, velocity, and temperature was mapped over the flow field of a 31.5 kW plasma torch. The effects of varying the powder loading were studied. The powder feed rate was varied between .45 and 2.05 kg/hr independent of the carrier gas flow rate. The particle flow field was non-symmetric due to the method of particle injection. The data indicate that powder feed rate does not significantly affect either the temperature or velocity of the particles, for typical plasma spray conditions, and that the assumption of a dilute particle flow field is valid.

DOE

**N91-17744#** Lawrence Livermore National Lab., CA.
**THE LLNL (LAWRENCE LIVERMORE NATIONAL LABORATORY) ICF (INERTIA CONFINEMENT FUSION) PROGRAM: PROGRESS TOWARD IGNITION AND GAIN IN THE LABORATORY**

E. Storm, S. H. Batha, T. P. Bernat, C. Bibeau, M. D. Cable, J. A. Caird, E. M. Campbell, J. H. Campbell, L. W. Coleman, and R. C. Cook et al 2 Oct. 1990 21 p Presented at the 13th International Conference on Plasma Physics and Controlled Nuclear Fusion Research, Washington, DC, 1-6 Oct. 1990 Submitted for publication
(Contract W-7405-eng-48)
(DE91-006256; UCRL-JC-106080; CONF-901025-38; IAEA-CN-53/B-2-3) Avail: NTIS HC/MF A03

The Inertial Confinement Fusion (ICF) Program at the Lawrence Livermore National Laboratory (LLNL) has made substantial progress in target physics, target diagnostics, and laser science and technology. In each area, progress required the development of experimental techniques and computational modeling. The objectives of the target physics experiments in the Nova laser facility are to address and understand critical physics issues that determine the conditions required to achieve ignition and gain in an ICF capsule. The LLNL experimental program primarily addresses indirect-drive implosions, in which the capsule is driven by x rays produced by the interaction of the laser light with a high-Z plasma. Experiments address both the physics of generating the radiation environment in a laser-driven hohlraum and the physics associated with imploding ICF capsules to ignition and high-gain conditions in the absence of alpha deposition. Recent experiments and modeling have established much of the physics necessary to validate the basic concept of ignition and ICF target gain in the laboratory. The rapid progress made in the past several years, and in particular, recent results showing higher radiation drive temperatures and implosion velocities than previously obtained and assumed for high-gain target designs, has led LLNL to propose an upgrade of the Nova laser to 1.5 to 2 MJ (at 0.35 (mu)m) to demonstrate ignition and energy gains of 10 to 20 -- the Nova Upgrade. DOE

**N91-17745#** Oak Ridge National Lab., TN. Solid State Div.
**IN-SITU LASER ABLATION PLASMA DIAGNOSTICS IN THE FILM GROWTH REGIME: EFFECTS OF AMBIENT BACKGROUND GASES**

D. B. Geohegan Nov. 1990 7 p Presented at the Fall Meeting of the Materials Research Society, Boston, MA, 26-29 Nov. 1990 Submitted for publication
(Contract DE-AC05-84OR-21400)
(DE91-006332; CONF-901105-60) Avail: NTIS HC/MF A02

The propagation of the laser-induced plasma formed by KrF irradiation of Y1Ba2Cu3O7 was characterized in background pressures of oxygen and argon typically used for thin film growth. The ion current transmitted through the background gases was recorded along the normal to the irradiated pellet as a function of distance in order to measure the decreasing velocity and magnitude of the expanding plasma current due to collisional slowing and attenuation of the laser plume. The integrated ion charge delivered to a substrate at low pressures can be described by elastic scattering giving a general integral cross sections of sigma(sub e)(O2) = 3.2 x 10(exp -16) sq cm and sigma(sub e)(Ar) = 2.7 x 10(exp -16) sq cm. At higher pressures, inelastic scattering leads to increased recombination and reactive conversion of ions indicated by increased fluorescence of all the species, which becomes dominated by fluorescence of YO and BaO. Spatially resolved fluorescence measurements indicate that the luminous boundary to the plasma follows a weak shock front which coincides with the ion flux propagation. The ion transmission is found to

drop exponentially with distance and background pressure, in agreement with a simple scattering model which yields general scattering cross sections for ion-argon sigma(sub i-Ar) = 2.1 x 10(exp -16) sq cm and ion-oxygen sigma(sub i-O2) = 2.3 x 10(exp -16) sq cm interactions in background pressures up to 300 mTorr. The general features of the plume deceleration are described in terms of a drag force model. DOE

**N91-17746#** Lawrence Livermore National Lab., CA.
**COMPREHENSIVE NUMERICAL MODELLING OF TOKAMAKS**
R. H. Cohen, B. I. Cohen, and P. F. Dubois 3 Jan. 1991 15 p Submitted for publication
(Contract W-7405-eng-48)
(DE91-006219; UCRL-ID-105650) Avail: NTIS HC/MF A03

We outline a plan for the development of a comprehensive numerical model of tokamaks. The model would consist of a suite of independent, communicating packages describing the various aspects of tokamak performance (core and edge transport coefficients and profiles, heating, fueling, magnetic configuration, etc.) as well as extensive diagnostics. These codes, which may run on different computers, would be flexibly linked by a user-friendly shell which would allow run-time specification of packages and generation of pre- and post-processing functions, including workstation-based visualization of output. One package in particular, the calculation of core transport coefficients via gyrokinetic particle simulation, will become practical on the scale required for comprehensive modelling only with the advent of teraFLOP computers. Incremental effort would be focused on gyrokinetic simulation and development of the shell. DOE

**N91-17747#** Lawrence Livermore National Lab., CA.
**OPTICAL CHARACTERIZATION OF DAMAGE RESISTANT KILOLAYER RUGATE FILTERS**
M. L. Elder, K. S. Jancaitis, D. Milam, and J. H. Campbell 17 Dec. 1990 12 p Presented at the 22nd Boulder Damage Symposium, Boulder, CO, 25-26 Oct. 1990 Submitted for publication
(Contract W-7405-eng-48)
(DE91-006245; UCRL-JC-105036; CONF-9010287-4) Avail: NTIS HC/MF A03

Multilayer dielectric optical coatings produced by high temperature plasma-assisted chemical vapor deposition (PCVD) have been previously shown to have very high surface and bulk damage thresholds (above 40J/sq cm). Because these experimental coatings are deposited on tubular substrates, conventional wavelength scanning cannot accurately measure the coating peak reflectance and bandwidth. Measurement of the variation of transmittance with incidence angle at a fixed wavelength permits analysis of the coating spectral response. The results indicate that the PCVD coatings behave as nearly ideal rugate filters. Their optical performance agrees well with that predicted for a rugate by Southwell's coupled-wave theory and by the characteristic-matrix model. These 1000-layer-pair filters have maximum reflectances exceeding 99.9 percent, peak reflectance wavelengths within 0.5 percent of the design wavelength, and FWHM bandwidths narrower than 10 nm. Minor perturbations to the ideal rugate sinusoidal profile do not appreciably affect the coating optical performance. Comparison with calculations suggest that the only significant deviation of the PCVD structure from that of an ideal rugate is a small (0.7 percent) drift in the index period. Excellent optical performance and high damage resistance makes PCVD rugate coatings potentially useful for several high power laser applications. DOE

**N91-17748#** Lawrence Livermore National Lab., CA.
**EXPERIMENTAL STUDY OF FILAMENTATION IN LASER-PLASMA INTERACTIONS**
P. E. Young 7 Jan. 1991 19 p Presented at the 32th Annual Meeting of the American Physical Society, Cincinnati, OH, 12-16 Nov. 1990 Submitted for publication
(Contract W-7405-eng-48)
(DE91-006510; UCRL-JC-104403; CONF-9011127-13) Avail: NTIS HC/MF A03

The filamentation instability can lead to regions of increased laser intensity when a spatially nonuniform laser beam interacts with a plasma. An experimental technique will be described which identifies the density perturbation produced by filaments. The growth of filaments has been investigated and, when the laser intensity is large enough, the transverse density profile of the filament can be measured. Evidence of filament growth influenced by plasma flow and density gradients is presented. DOE

**N91-17749#** Lawrence Livermore National Lab., CA.
**STAGNATION AND INTERPENETRATION OF LASER-CREATED COLLIDING PLASMAS**
S. M. Pollaine, J. R. Albritton, R. Kauffman, C. J. Keane, R. L. Berger, R. Bosch, N. D. Delameter, and B. H. Failor (KMS Fusion, Inc., Ann Arbor, MI.) 5 Nov. 1990 23 p Presented at the 32nd Annual Meeting of the American Physical Society, Cincinnati, OH, 12-16 Nov. 1990 Submitted for publication
(Contract W-7405-eng-48)
(DE91-006515; UCRL-JC-104425; CONF-901127-12) Avail: NTIS HC/MF A03

A KMS laser experiment collides Aluminum (Al) and Magnesium (Mg) plasmas. The measurements include electron density, time and space resolved Ly-alpha and He-alpha lines of Al and Mg, and x ray images. These measurements were analyzed with a hydrodynamic code, LASNEX, and a special two fluid code OFIS. The results strongly suggest that at early times, the Al interpenetrates the counterstreaming Mg and deposits in the dense Mg region. At late times, the Al plasma stagnates against the Mg plasma. DOE

**N91-17750#** Argonne National Lab., IL. Materials Science Div.
**LI OVERLAYER FORMATION, OXIDATION, AND SPUTTERING CHARACTERISTICS OF Al-Li ALLOYS AND W/Al-Li COMPOSITES FOR FUSION APPLICATIONS**
A. R. Krauss, A. B. DeWald, P. Scott, and H. Savage (Corium Industries, Inc., Atlanta, GA.) 1990 20 p Presented at the 9th Topical Meeting on Technology of Fusion Energy, Chicago, IL, 7-11 Oct. 1990
(Contracts W-31-109-eng-38; DE-AC05-87ER-80508)
(DE91-006529; CONF-901007-51) Avail: NTIS HC/MF A03

The next generation of long pulse fusion devices will impose severe requirements on the properties of plasma-facing materials. In devices such as the International Thermonuclear Experimental Reactor (ITER), a divertor design is being considered, using a divertor plate which would be either tungsten or a low-Z material such as graphite or beryllium. Strongly segregating lithium alloys have been proposed as a means of producing a self-sustaining low-Z overlayer which lowers plasma Z(sub eff) and resists self-sputtering. Aluminum-lithium alloys are among the better-characterized lithium-bearing alloys, and it has been demonstrated that lithium segregates strongly in aluminum. However, aluminum has a relatively low melting point, and for low lithium concentrations, the lithium diffusion rate is too slow to replenish lithium at the rate at which it is eroded by the incoming plasma. It has been suggested previously that the superionic (beta) phase Al-Li alloy (48 to 54 at. percent Li) should have high enough diffusivity to be able to replenish surface lithium, and that incorporation of the (beta)-phase AlLi in a composite with tungsten would provide high temperature strength and melt layer stability, along with significantly better thermal conductivity than pure tungsten. Such a composite has been fabricated, as well as a variation containing titanium as a means of controlling oxidation at grain boundaries. The Li overlayer formation, erosion, and replenishment are characterized for the (beta)-phase LiAl alloy, and W-AlLi and W-Ti-AlLi composites. It is found that if there is no oxide layer to inhibit the Li segregation, Li diffusion is extremely rapid, and an oxygen-free Li overlayer is formed which is stable under continuous ion beam sputtering. DOE

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Includes superconductivity.

For related information, see also *33 Electronics and Electrical Engineering* and *36 Lasers and Masers.*

**N91-17751#** Los Alamos National Lab., NM.
**CHANGES IN Fe SITE OCCUPANCY AND (Tc) IN YBa2(Cu(1-x)Fe(x))3O(y) THROUGH PROCESSING**
H. Oesterreicher, Michael G. Smith, and R. Dean Taylor Apr. 1990 10 p Presented at the ICMC '90 Topical Symposium on High Temperature Superconductors: Materials Aspects, Garmisch-Partenkirchen, Fed. Republic of Germany, 9-10 May 1990
(Contract W-7405-eng-36)
(DE90-010614; LA-UR-90-1402; CONF-900527-2) Avail: NTIS HC/MF A02

Fe substitution for Cu in YBa2Cu3O(y) can give information about the local environment on the two crystallographic Cu sites through Mossbauer effect measurements. In this paper, we explore the possibility of forcing larger amounts of Fe onto the Cu (2) site which represents the CuO planes. At values near y = 6, the chain Cu (1) site is characteristic for Cu(+) in its linear 0 coordination and should preclude Fe occupation. Materials were prepared at elevated temperatures under N2 where y is approximately 6. Oxygenation to y is approximately 7 was achieved at temperatures where metal diffusion is minimized. Mossbauer spectroscopy was used to determine the Fe site occupancy. Site preference can be expressed in terms of a distribution ratio r = MCul/ MCu2. Creating materials with low r allows studying the effects of spatially constrained Fe on T(sub c), separating influences from the spatially more complex Cu (1) site. DOE

**N91-17752#** Sandia National Labs., Albuquerque, NM.
**FIELD DEPENDENCE OF INTERFACE TRAP BUILDUP IN Si-GATE MOS DEVICES**
M. R. Shaneyfelt (Allied-Signal Corp., Albuquerque, NM.), J. R. Schwank, D. M. Fleetwood, P. S. Winokur, and F. W. Sexton 1990 5 p Presented at the 27th IEEE Annual International Nuclear and Space Radiation Effects Conference, Reno, NV, 16-20 Jul. 1990
(Contract DE-AC04-76DP-00789)
(DE90-007679; SAND-90-0436C; CONF-900723-10) Avail: NTIS HC/MF A01

Radiation-induced interface traps in Si-gate MOS devices follow an E(exp -1/2) electric field dependence for E greater than or equal to +0.13 MV/cm when electron-hole recombination effects are included. A hybrid model involving hole trapping and hydrogen transport is suggested. DOE

**N91-17753** Michigan Univ., Ann Arbor.
**NONLINEAR OPTICAL STUDIES OF RELAXATION IN SEMICONDUCTOR MICROSTRUCTURES Ph.D. Thesis**
Jeffrey Thomas Remillard 1990 154 p
Avail: Univ. Microfilms Order No. DA9023622

Exposing a semiconductor to optical radiation near the fundamental band gap results in the creation of populations or elementary excitations including electrons, holes, and excitons, and also results in the creation of a superposition state between the ground and excited state of the solid. The relaxation of optically generated excitons and carriers in semiconductor microstructures was studied using four wave mixing (FWM) spectroscopy. The systems studied include CdSSe microcrystallite doped glasses and GaA/AlGaAs multiple quantum well structures (MQWS). First, the nonlinear optical response of simple two level systems is examined in order to provide insight into the types of line shapes expected from semiconductors. It is shown that the line shape is strongly dependent on how the system is coupled to the reservoir and the consequences of coupling to a reservoir are examined in a FWM measurement made in atomic sodium. The first semiconductor system studied is CdSSe microcrystallite doped glass. This system is shown to have a very slow component to the nonlinear response which has an optical intensity dependence and temperature dependence which suggests that the FWM response in these materials is trap mediated. Room temperature FWM measurements in GaAs MQWS enables the measurement of the carrier recombination time and the ambipolar diffusion coefficient. Using the technique of correlated optical fields, a slow component to the nonlinear response was measured showing an interference profile which suggests a possible shift of the exciton resonance due to the optically generated carriers. At low temperatures, measurements of the exciton line shape and relaxation time were made and evidence for exciton spectral diffusion was found. The low temperature line shapes can be qualitatively reproduced using Modified Optical Bloch equations which include the effects of spectral diffusion. Dissert. Abstr.

**N91-17754** Notre Dame Univ., IN.
**STUDIES IN THE THEORY OF SEMICONDUCTORS Ph.D. Thesis**
Run-Di Hong 1990 165 p
Avail: Univ. Microfilms Order No. DA9024608

Central-cell resonant impurity scattering was studied in A(sup IV)B(sup VI) semiconductors. The electronic band structure of A(sup IV)B(sup VI) narrow gap semiconductors was reviewed. The electron mobilities of In-doped PbTe and Pb(0.82)Sn(0.18)Te are explained quantitatively in terms of conventional electron-phonon scattering at high temperatures and resonant scattering by the central-cell potential of Te-site In at low level above the conduction band is responsible for the anomalously low observed mobilities. Such resonant scattering should affect mobilities in other A(sup VI)B(sup VI) semiconductors as well. Pressure dependences of deep impurity levels was carefully studied in semiconductors. The derivatives with respect to hydrostatic pressure are predicted for deep levels associated with s- and p-bonded impurities in zinc-blende semiconductors as well as in rocksalt semiconductors. It is shown that by combining data, both for deep levels and for their hydrostatic-pressure derivatives, with theory it is often possible to determine the site of the impurity, the symmetry of the deep level, and a quite small number of substitutional s- and p-bonded impurities that could be responsible for the data. The pressure dependence of deep levels in BaAs/Al(x)Ba(1-x)As superlattices are also studied. The deep level theory is applied to the diluted magnetic semiconductors. The standard dopant Ga is predicted to change its character from a shallow donor to a deep trap with increasing alloy composition x in Zn(1-x)Mn(x)Se. In addition, an explanation is proposed for the fact that ZnTe is unique among the II-VI semiconductors in that it can be doped p-type rather easily: The native and foreign antisite defects Zn(sub Te) and Li(sub Te) are shallow acceptors in ZnTe, while the corresponding defects are deep traps in most other II-VI semiconductors. These antisite defects undergo shallow-deep transitions as a function of increasing Se composition x in ZnTe(1-x)Se(x) alloys. The possibility of doping ZnSe p-type with Be is also proposed and discussed. Dissert. Abstr.

**N91-17755** New South Wales Univ., Sydney (Australia). Dept. of Condensed Matter Physics.
**AMORPHOUS HYDROGENATED SILICON DOPING MODULATED MULTILAYERS AND COMPENSATED FILMS Ph.D. Thesis Abstract Only**
Dao-Hua Zhang 1989 3 p
Avail: Issuing Activity

Nipi multilayers synthesized with very thin dope and undoped layers in one chamber by glow discharge decomposition show strong persistent photoconductivity effect (PPC). It was found that the PPC shows two kinds of decay processes, a power law time dependence for the first several hours, and thereafter an exponential relation. The relation between PPC and exposure time, light intensity, RF power, multi-illumination, and i-layer thickness of the multilayers were studied. Dissert. Abstr.

**N91-17756#** Air Force Systems Command, Wright-Patterson AFB, OH. Foreign Technology Div.
**THE FABRICATION AND CHARACTERISTICS OF YB2Cu3O(7-x)/W AND Y2O3/W FIELD EMITTERS**
Xiang-Qi Jiang, Xi-Liang Yang, and Hui Xu 24 Sep. 1990 14 p

Transl. into ENGLISH from Dianzi Xuebao (Peoples Republic of China), v. 17, no. 6, Nov. 1989 p 101-104
(AD-A227561; FTD-ID(RS)T-0579-90) Avail: NTIS HC/MF A03 CSCL 20/3

The Y2O3/W and YBa2Cu3O(7-x)/W field emitters have been fabricated and the corresponding field emission patterns have been obtained. For the same dimensions and parameters, the field emission current of Y2O3/W is higher and more stable than that of W tip. By measuring field emission currents and voltages and plotting the data in accordance with the Fowler-Nordheim equation, the work function of YBa2Cu3O(7-x)/W was found to be 4.1eV at room temperature. Thermal Field Emission (TFE) can be applied to obtain high intensity brightness and, therefore, has been under scientific study in recent years. The choice of appropriate materials for the fabrication of the field emitter is an important topic in the study of thermal field emission. GRA

**N91-17757#** National Inst. of Standards and Technology, Gaithersburg, MD. Center for Electronics and Electrical Engineering.
**SEMICONDUCTOR TECHNOLOGY FOR THE NON-TECHNOLOGIST, 2ND EDITION**
R. I. Scace Sep. 1990 39 p
(PB91-107193; NISTIR-4414) Avail: NTIS HC/MF A03 CSCL 20L

The properties of semiconductor materials, the methods of processing them, and the solid state products made from them are described in terms intended to be understandable by the lay person. The semiconductor industry has grown at a rate of 21 percent per year compounded for the last 20 years, and its products have declined in unit cost by a factor of five in current dollars (a factor of ten in constant dollars) in the same period. This very satisfactory but anomalous behavior has attracted the interest of many who are not familiar with the technology of the industry, yet who need to have some understanding of it. This report is intended to help meet that need. Author

**N91-17758#** Research Triangle Inst., Research Triangle Park, NC.
**SEMICONDUCTOR DIAMOND TECHNOLOGY Quarterly Report No. 2, 1 Apr. - 30 Jun. 1990**
R. J. Markunas, R. A. Rudder, J. B. Posthill, and R. E. Thomas 1 Nov. 1990 43 p
(Contract N00014-86-C-0460)
(AD-A228607; RTI-83U-3629) Avail: NTIS HC/MF A03 CSCL 20/12

Semiconducting diamond technology development this quarter has focussed on: (1) metal substrate development by the formatin of ultra-thin refractory metal layers on Ni(100) surfaces, (2) advancement toward ALE by obtaining absorption/desorption data from Si(100) surfaces fro hydrogen and halogen species in the surface chemistry facility, (3) continuing development of low pressure rf-plasma assisted diamond CVD for diamond device fabrication. A diamond FET fabrication sequence that utilizes selective area epitaxy of doped diamond on an insulating diamond single crystal substrate is proposed. This process sequence takes advantage of (1) well-established lithography and etching processes for mask materials, (2) the fact that diamond is difficult to nucleate on most materials that could be used as a masking layer, and (3) the established capability of depositing gate-quality dielectrics by RPECVD. Selective area diamond homoepitaxy has been demonstrated through lithographically defined windows in Si and Ni masking layers. Additionally, diamond is observed to overgrow (epitaxially and laterally) the Si masking layer at approximately the same rate as the vertical epitaxy. GRA

**N91-17759#** Research Triangle Inst., Research Triangle Park, NC.
**SEMICONDUCTOR DIAMOND TECHNOLOGY Quarterly Report No. 1, 1 Jan. - 31 Mar. 1990**
R. J. Markunas, R. A. Rudder, J. B. Posthill, and R. E. Thomas 1 Nov. 1990 23 p
(Contract N00014-86-C-0460)
(AD-A228608; RTI-83U-3629) Avail: NTIS HC/MF A03 CSCL 09/1

The semiconducting diamond technology development this quarter has concentrated on the continuing advance of a low pressure rf-plasma assisted chemical vapor deposition technique and the advance of the surface chemistry facility. Basic studies of the low pressure rf-plasma assisted CVD system have shown the plasma to be a chemically reactive plasma which converts CH4 into C2H2, produces atomic H, and gasifies graphitic carbon. The power input into the discharge is sufficient to maintain the discharge in the red mode where the plasma emission is dominated by atomic hydrogen emission. The atomic hydrogen population is estimated to be at approximately 2500 K. The surface chemistry facility will be an important tool enabling elucidation of CVD processes in diamond growth. GRA

**N91-17760#** Pennsylvania State Univ., University Park. Dept. of Engineering Science and Mechanics.
**ELECTRON SPIN RESONANCE AND RADIATION EFFECTS IN MOS DEVICES Technical Report, 1 Jun. 1986 - 30 Jun. 1989**
P. M. Lenahan and M. A. Jupina Oct. 1990 90 p
(Contract DNA001-86-C-0055)
(AD-A228651; DNA-TR-89-242) Avail: NTIS HC/MF A05 CSCL 09/1

The basic mechanisms were explored of radiation damage in metal oxide silicon field effect transistors (MOSFET's) with a combination of electron spin resonance (ESR) and electrical measurements. The major focus was to develop a new and much more sensitive ESR technique called spin dependent recombination (SDR) to study radiation damage in MOSFET's. GRA

**N91-17761#** California Univ., Los Angeles. Dept. of Physics.
**SURFACE IMPEDANCE OF HIGH Tc SUPERCONDUCTORS**
G. Gruner 1990 11 p Presented at the International Winterschool on Electronic Properties of High Tc Superconductors, Kirchberg, Fed. Republic of Germany, 1990 Sponsored by ONR
(AD-A228673) Avail: NTIS HC/MF A03 CSCL 20/12

The various experiments are discussed which give information on the surface impedance Zs = Rs + jXs of high temperature superconductors. The surface reactance Xs is related to the penetration depth and Xs(T) is suggestive for singlet pairing. The surface resistance Rs is determined by the ac losses due to imperfections and due to thermally excited carriers, and experiments on high quality YBa2Cu3O7 films indicate a superconducting gap which exceeds the BCS weak coupling limit. The various high frequency device applications are also briefly discussed. GRA

**N91-17762#** National Inst. of Standards and Technology, Gaithersburg, MD. Semiconductor Electronics Div.
**SEMICONDUCTOR MEASUREMENT TECHNOLOGY: THERMAL RESISTANCE MEASUREMENTS Final Report**
F. F. Oettinger and D. L. Blackburn Jul. 1990 79 p
(PB90-269564; NIST/SP-400/86) Avail: NTIS HC/MF A05; also available SOD HC $4.25 as 003-003-03035-0 CSCL 20L

The thermal properties of power transistors and integrated circuits are reviewed, and methods for characterizing these properties are discussed. The discrete devices discussed include bipolar transistors and metal oxide semiconductor field effect transistors. Measuring problems common to these devices, such as deciding the reason for requiring a particular measurement, adequate reference temperature control, selection of a temperature-sensitive electrical parameter, and separation of electrical and thermal effects during measurement are addressed. Due to the inherent difficulties in measuring and analyzing the thermal properties of active integral circuits, an approach using specifically designed thermal test chips for evaluation of new die-attachment and packaging schemes is finding wide acceptance in the industry. Indirect (i.e., electrical) measurements, direct (e.g., infrared) measurements, and computer simulation techniques for thermally characterizing integrated circuits are discussed in terms of their usefulness in characterizing VLSI packages. Y.S.

**N91-17763#** North Carolina State Univ., Raleigh. Dept. of Electrical and Computer Engineering.
**A THEORETICAL SEARCH FOR SUPERVELOCITY SEMICONDUCTORS Report, 1 Oct. 1989 - 30 Sep. 1990**
M. A. Littlejohn and K. W. Kim 30 Sep. 1990 105 p
(Contract N00014-90-J-1553)
(AD-A228718) Avail: NTIS HC/MF A06 CSCL 20/12

The research has resulted in major contributions to the field of hot electron transport and semiconductor device modeling was achieved, new computational methods were developed (e.g., path integral Monte Carlo techniques), and the work has helped stimulate commercial ventures in the applications of quaternary semiconductor materials to electronic and optical devices. This initial phases of this work centered around the development of Monte Carlo simulation techniques which allow the study of detailed physics of hot electron transport in a variety of compound semiconductor materials. Recent effort focused in four areas along with the continuation of the basic research directions encompassing the study of hot electron transport in materials and devices. These four areas included (1) the study of quantum transport in resonant tunneling and related ultra-small heterobarrier device structures using the Feynman path integral and the transmission matrix methods, (2) the study of the physics of hot electron and heterojunction device structures, (3) some new approaches to the merging of Monte Carlo methods with moment equation methods with resulting improvements to the hydrodynamic transport model, and (4) new Monte Carlo simulation in order to study pseudomorphic devices, delta-doped structures, and submicron MOSFETs. GRA

**N91-17764#** State Univ. of New York, Buffalo. Dept. of Chemistry.
**SURFACE-INDUCED OPTICAL BISTABILITY IN COUPLED EXCITON-PHONON SYSTEMS**
D. L. Lin, Xiao-shen Li, and Thomas F. George Nov. 1990 20 p Submitted for publication
(Contract N00014-90-J-1193)
(AD-A228833; UBUFFALO/DC/90/TR-28) Avail: NTIS HC/MF A03 CSCL 20/12

Nonlinear optical responses of excitation-phonon-coupling systems near a reflective surface are investigated. For a polydiacetylene chain lying parallel to the surface, optical bistability induced by the surface is discovered. It is also found that the threshold and contrast of the bistability can be controlled by adjusting the distance of the system from the surface, and that vacuum fluctuations are reduced whenever the bistability occurs. The nature of the bistability and its origin are discussed. GRA

**N91-17765#** Aerospace Corp., El Segundo, CA. Lab. Operations.
**TEM LATTICE IMAGING OF THE NANOSTRUCTURE OF EARLY-GROWTH SPUTTER-DEPOSITED MoS2 SOLID LUBRICANT FILMS**
Michael R. Hilton and Paul D. Fleischauer 30 Sep. 1990 53 p
(Contract F04701-88-C-0089)
(AD-A228943; TR-0089(4945-03)-3; SSD-TR-90-37) Avail: NTIS HC/MF A04 CSCL 20/2

Transmission electron microscopy (TEM) was used to investigate the nanostructure of sputter deposited molybdenum disulfide (MoS2) films. These films represent the early stages of growth under deposition conditions that produce a zone 2 columnar morphology. Analysis reveals that the early growth film morphology consists of anisotropic (platelike) islands in which the (001) basal planes are generally perpendicular to the substrate (forming edge islands) or parallel to the substrate (forming basal islands). Within the context of an active-sites nucleation model, localized regions of the substrate surface can lack the active sites needed to induce edge orientation. The edge islands evolve into the zone 2 morphology, shadowing and inhibiting the continued growth of the basal islands. Basal plane (002) lattice image curvature and kinking were observed in the edge islands. Dark-field analysis showed intensity variations within the edge islands. The edge island plates appear to be imperfect crystals of aligned basal planes. These crystals can bend, kink, or twist, apparently because of variations in local growth conditions. The ability of crystal growth to deviate has implications for the morphological evolution of thicker films. The ability of the MoS2 crystal lattice to bend supports the idea that localized deformation can occur during sliding wear. GRA

**N91-17766#** Lawrence Livermore National Lab., CA.
**SUPERCONDUCTING ENERGY GAP AND NORMAL STATE CONDUCTIVITY OF A SINGLE DOMAIN Y1Ba2Cu3O7 CRYSTAL**
Z. Schlesinger, R. T. Collins, F. Holtzberg, C. Feild, S. H. Blanton, U. Welp, G. W. Crabtree, Y. Fang, and I. Z. Liu (California Univ., Davis.) Sep. 1990 17 p
(Contracts W-7405-eng-48; W-31-109-eng-38; NSF STC-88-09854)
(DE91-005199; UCRL-CR-106037) Avail: NTIS HC/MF A03

Using polarized reflectivity measurements of single domain crystals, we are able to distinguish chain and plane contributions to the infrared conductivity of Y1Ba2Cu3O7. A substantial chain contribution to sigma (omega) persisting to low frequency and temperature is observed. For the intrinsic conductivity of the CuO2 planes a superconducting energy gap of 500/cm (2delta/k(T sub c) approximately equal to 8) is evident in the infrared data, while the normal state conductivity drops much more slowly with omega than the ordinary Drude form, and can be described in terms of a scattering rate Dirac h/(tau)* approximately kT + Dirac h(omega) at low frequency. The former result (2(Delta)/k(T sub c) approximately equal to 8) suggests substantial suppression of T(sub c); the latter, that Y1Ba2Cu3O7 is not an ordinary Fermi liquid. DOE

**N91-17767#** California Univ., Berkeley. Lawrence Berkeley Lab. Materials and Chemical Sciences Div.
**FABRICATION AND MEASUREMENT OF HIGH Tc SUPERCONDUCTING MICROBOLOMETERS**
M. Nahum, Qing Hu, Paul L. Richards, S. A. Sachtjen, N. Newman, and B. F. Cole (Conductus, Inc., Sunnyvale, CA.) Sep. 1990 5 p Presented at the Applied Superconductivity Conference, Aspen, CO, 24-28 Sep. 1990
(Contract DE-AC03-76SF-00098)
(DE91-005234; LBL-28990; CONF-900944-24) Avail: NTIS HC/MF A01

The performance was measured of antenna coupled microbolometers based on the resistive transition of a high (Tc) superconducting film for use as detectors of far infrared and millimeter waves. A planar lithographed antenna (log periodic or log spiral) is used to couple the radiation to a thin YBCO film with dimensions (approx 6 x 13 sq microns) which are smaller than the wavelength to be measured. This film acts both as the resistor to thermalize the RF currents and as a transition edge thermometer to measure the resulting temperature rise. Because of its small size, both the thermal conductance from the film into the bulk of the substrate and the heat capacity of the thermally active region are small. Consequently, the microbolometer has low noise, fast response and a high voltage responsivity. A phonon limited electrical NEP was measured of 4.5 x 10(exp -12) WHz(exp -1/2) at 10 kHz modulation frequency and a responsivity of 478 V/W at a bias of 550 micro-A. Measurements of the optical efficiency are in progress and are discussed. DOE

**N91-17768#** California Univ., Berkeley. Dept. of Physics.
**RECENT DEVELOPMENTS IN SUPERCONDUCTING RECEIVERS**
Paul L. Richards Sep. 1990 7 p Presented at the 2nd International Forum on the Frontier of Telecommunications Technology, Tokyo, Japan, 23-24 Oct. 1990 Prepared in cooperation with California Univ., Berkeley, Lawrence Berkeley Lab.
(Contract DE-AC03-76SF-00098)
(DE91-005402; LBL-29687; CONF-9010275-1) Avail: NTIS HC/MF A02

A description is given of recent work at Berkeley on superconducting mixers and detectors for infrared and millimeter

wavelengths. The first report is a review article which summarizes the status of development of superconducting components for infrared and millimeter wave receivers. The next report describes accurate measurements and also theoretical modeling of an SIS quasiparticle waveguide mixer for W-band which uses very high quality Ta junctions. The best mixer noise is only 1.3 times the quantum limit. Both the mixer gain and the noise are in quantitative agreement with the quantum theory. Next, a report is given on measurements and theoretical modeling of the absorptivity (surface resistance) of high quality epitaxial films of the high Tc superconductor YBCO from 750 GHz to 21 THz. Finally, there are reports on the design and experimental performance of two different types of high Tc bolometric detectors. One is a conventional bolometer with a gold-black absorber. The other is an antenna coupled microbolometer. DOE

**N91-17769#** Washington Univ., Seattle. Dept. of Physics.
**X RAY AND GAMMA RAY SPECTROSCOPY OF SOLIDS UNDER PRESSURE Annual Technical Progress Report, Oct. 1987 - Oct. 1990**
Robert L. Ingalls 20 Apr. 1990 12 p
(Contract DE-FG06-84ER-45163)
(DE91-005566; DOE/ER-45163/23) Avail: NTIS HC/MF A03

This report briefly describes our studies of various materials at high pressures by means of x ray and gamma-ray absorption spectroscopy. High pressure provides a very effective means of studying materials. Virtually every property is altered from the color and crystal structure to the electrical and magnetic properties. The fundamental reason, of course, is that the quantum levels depend upon the atomic spacing so that both the electronic and vibrational structure is affected. DOE

**N91-17770#** Central Research Inst. of Electric Power Industry, Tokyo (Japan). Energy and Environment Lab.
**PRESENT R AND D STATUS OF HIGH-Tc SUPERCONDUCTORS AND PROSPECTS FOR POWER APPLICATIONS**
Y. Ando and S. Akita Mar. 1990 36 p In JAPANESE; ENGLISH summary
(DE91-736780; CRIE-T-89035) Avail: NTIS HC/MF A03

Since the discovery of high-T(sub c) oxide superconductors, their use by electric power utilities has attracted a great deal of interest. This report reviews the present research and development (R and D) status of high-T(sub c) oxides, and recommends the R and D items and approaches for ac applications. The main results are as follows: (1) the key aspects of the microstructure of high-T(sub c) oxides are anisotropic and granularity; (2) the value of the ac loss divided by the critical current density of High-T(sub c) superconducting sample wires at this stage is about 100 times that of conventional low-T(sub c) superconducting ac wires; and (3) to develop a low ac-loss wire, anisotropy and surface-pinning must be taken advantage of, and a way to control granularity must be investigated. DOE

**N91-17771** Council for National Academic Awards (England).
**EXPERIMENTAL STUDIES ON BULK AND THICK FILM HIGH Tc SUPERCONDUCTORS Ph.D. Thesis**
Leslie Kirkup 1990 214 p
Avail: Univ. Microfilms Order No. BRDX90472

Characteristics of bulk and thick film samples of the RBa2Cu3O(7-delta) family of high Tc superconductors where R represents yttrium and selected rare-earth atoms are considered. Ceramic superconductors, prepared using the solid state reaction method, were characterized by means of electrical, chemical, x ray, and electron microscopy techniques. The resistance of electrical contacts made to samples of superconductor was studied as a function of temperature. Current-voltage (I-V) characteristics as a function of temperature were obtained for YBa2Cu3O(7-delta) and NdBa2Cu3O(7-delta). From these measurements a value for the energy gap in these materials at OK is inferred using the Ambegaokar-Baratoff relationship for the temperature dependence of the weak link critical current. The functional form of the I-V curves is shown to exhibit a simple power law dependence. Comparison is made with predicted I-V relationships based o 2- and 3-dimensional models of percolative superconductivity. Close to the critical temperature, it is observed that V varies as I(sup 1.5). The effect on critical current of small applied magnetic fields was studied. Thick films of YBa2Cu3O(7-delta) superconductor were prepared on Al1O3 and AlN substrates using the technique of screen printing. Processing procedures are discussed and the electrical characteristics of the films are presented.
Dissert. Abstr.

**N91-17772** Harvard Univ., Cambridge, MA.
**STRUCTURE AND STRESS OF SEMICONDUCTOR SURFACES Ph.D. Thesis**
Robert David Meade 1990 104 p
Avail: Univ. Microfilms Order No. DA9035516

Several problem are addressed regarding the surfaces of semiconductors. In particular, the focus is on the role of stress in determining surface structure. To do this, two sets of technique are examined. In order to calcuate the stress on surfaces of real material, first-principles calculations were performed in the local density approximation. This study has focused on the surfaces of silicon and germanium. The elasticity theory was employed to explore the consequences of stress on the surfaces. A simple continuum model is solved analytically to show that a class of surfaces is unstable to the formation of stress domains. Calculations of the structure and energetics of adatom-covered Si(111) and Ge(111) surfaces were performed. Calculations at high plane wave cut-off unambiguously identify the 2 x 2 top-site geometry as the energetically preferred adatom configuration. The stress of 1 x 1 substitutional and the square root of 3 x the square root of 3 and 2 x 2 adatom-covered Si(111) and Ge(111) surfaces were calculated, using a variety of column-III, IV, and V absorbates. Trends in surface stresses are understood in terms of three contributing factors: the relative atomic size of the adsorbate and substrate atoms, the chemical nature of the adsorbate species, and the bonding topology of the surface reconstruction. The calculation of stress is also discussed. In order to hasten convergence of the stress, it is useful to remove a fictitious tensile stress resulting from the finite basis size. There are numerous consequence of stress on surfaces. Crystals which reconstruct with broken orientational symmetry and exhibit an anisotropic stress tensor are unstable to the formation of elastic stress domains. The ground state of such a surface is not uniform, but corresponds to a mosaic pattern of differing domains.This result is applied to the case of the Si(100) surface. Dissert. Abstr.

**N91-17773** California Univ., San Diego.
**InGaAs/InAlAs LATTICE-MISMATCHED HETEROJUNCTION INSULATED-GATE FIELD EFFECT TRANSISTORS GROWN ON GaAs Ph.D. Thesis**
Peter Chu 1990 257 p
Avail: Univ. Microfilms Order No. DA9033344

The heterojunction insulated-gate field effect transistor (HIGFET) was developed using lattice-mismatched InGaAs and InAlAs layers to demonstrate the effective utilization and advantages of strained layers. To increase the fractional In content in the device channel and therefore improve the device characteristics without giving up performance due to defects generated by a large lattice-mismatch with the GaAs substrate, it becomes necessary to interpose a buffer which can act as an artificial substrate for the channel, in essence decoupling the channel from the true substrate. In order to protect the channel and subsequently grown layers from propagating dislocations generated at the buffer/substrate interface, a strained layer superlattice lattice-matched to the new artificial lattice constant is inserted within the buffer to act as a dislocation filter.
Dissert. Abstr.

**N91-17774#** Cornell Univ., Ithaca, NY.
**SUPERCONDUCTING MATERIALS AND DEVICES Final Report, 1 Feb. 1985 - 31 Jan. 1989**
Robert A. Buhrman 13 Nov. 1990 10 p

(Contract N00014-85-K-0296)
(AD-A228950) Avail: NTIS HC/MF A02 CSCL 20/3

This research program was concerned with the study of the phenomena of quantum superconductivity and with the evaluation of the potential for the application of such phenomena in superconducting electronic devices. The initial research efforts were focused on the study of the origin of 1/f noise in superconducting tunnel junctions and in ultra-high frequency effects and non-equilibrium phenomena in Josephson junctions. The 1/f noise research involved the study of the dynamic behavior of individual electronic defects in very small device structures. It led to the discovery of the reversible fluctuations of atomic defects between metastable configurations as the microscopic source of 1/f noise in tunnel junctions and in compound semiconductor device structures and to the discovery of strong, apparently lattice-mediated interactions, between these defects. With the discovery of high temperature superconductivity (HTS) partway through this research project a major portion of the research effort was redirected to the effort to fabricate and study high quality cuprate oxide superconductor thin films. This effort resulted in the first demonstration of the in-situ growth of HTS films and in their application in a number of studies that probed the nature of this new phenomenon. GRA

**N91-17775#** California Univ., Santa Barbara. Dept. of Materials.
**PARTITIONING REACTIONS TO CONTROL AND DEVELOP UNIQUE MICROSTRUCTURES Final Report, 15 Jun. 1987 - 15 Jun. 1990**
F. F. Lange 15 Sep. 1990 58 p
(Grant AF-AFOSR-0291-87; AF Proj. 2306)
(AD-A229029; TR-8; AFOSR-90-1139TR) Avail: NTIS HC/MF A04 CSCL 20/2

The studies reported include: (1) liquid precursor formulation, pyrolysis, compositional homogeneity, and densification; (2) crystallization vs. composition subsequent to pyrolysis; (3) high temperature phase partitioning of metastable structures produced during crystallization after pyrolysis; (4) grain growth phenomena as related to different binary, solid-solution cations and composition with different binary systems; (5) microstructural instabilities of polycrystalline thin films; (6) microstructural instabilities of polycrystalline fibers constrained by composite matrices; (7) formation of single crystal thin films as a function of differential composition and lattice mismatch; and (8) relations between processing flaws and strength for fibers produced by dry spinning. The pertinent results of these studies and their interrelations are summarized. GRA

**N91-17776#** Minnesota Univ., Saint Paul. School of Physics and Astronomy.
**HIGH TEMPERATURE SUPERCONDUCTING COMPOUNDS Final Technical Report, 1 Sep. 1987 - 30 Sep. 1990**
Allen M. Goldman and Martha L. Mecartney 1 Oct. 1990 12 p
(Grant AF-AFOSR-0372-87; AF Proj. 2306)
(AD-A229082; AFOSR-90-1149TR) Avail: NTIS HC/MF A03 CSCL 09/1

High-Tc superconductors have been investigated in both bulk and thin film form. A technique for the in-situ preparation of high-Tc superconducting films involving the use of ozone-assisted Molecular Beam Expitaxy has been developed. The procedures seem to be generalized to the extent that high quality trilayer and multilayer structures which would be useful scientifically and technologically are possible. In addition to the process working with the usual substrates, it has been possible to deposit films on Si substrates without any buffer layer. A bolometer has been successfully fabricated on a thermally isolated SiN substrate coated with YSZ. Very thin and transparent films with relatively high transition temperatures have been prepared. The magnetic properties of bulk polycrystalline and single crystal high temperature superconductors have been measured and reveal important features of flux pinning and anisotropy in these materials. A low temperature scanning tunneling microscope for the investigation of the surfaces of high-Tc superconductors has been developed. GRA

**N91-17777#** Materials Research Society, Pittsburg, PA.
**MATERIALS RESEARCH SOCIETY PROCEEDINGS: INTERFACES IN COMPOSITES, VOLUME 170 Final Report, 22 Nov. 1989 - 21 Nov. 1990**
Carlo G. Pantano, ed. and Eric J. H. Chen, ed. (Du Pont de Nemours, E. I. and Co., Wilmington, DE ) 21 Nov. 1990 379 p Symposium held in Boston, MA, 27-29 Nov. 1989
(Grant AF-AFOSR-0081-90; AF Proj. 2306)
(AD-A229200; AFOSR-90-1056TR-VOL-170) Avail: NTIS HC/MF A17 CSCL 09/1

Reports on the following topics are presented: (1) micromechanics of interfaces; (2) characterization of interfaces; (3) interface reactions in ceramic and metal systems; (4) interface effects in ceramic and metal matrix composites; and (5) interface effects in polymer matrix composites. A list of the materials research society symposium proceedings is also presented. K.S.

**N91-17778#** California Univ., San Diego, La Jolla. Dept. of Electrical and Computer Engineering.
**PHYSICS AND TECHNOLOGY OF III-V PSEUDOMORPHIC STRUCTURES Interim Report, 1 Oct. 1989 - 30 Sep. 1990**
C. W. Tu 15 Nov. 1990 105 p Presented at the 17th International Conference on Metallurgical Coatings and the 8th International Conference on Thin Films, San Diego, CA, 2-6 Apr. 1990
(AD-A229275; TU-ONR-90) Avail: NTIS HC/MF A06 CSCL 20/12

AlGaAs/InGaAs modulation doped field effect transistors with a nominally (InAs)2(GaAs)2 channel grown by migration enhanced epitaxy exhibit better luminescent and device properties than those with a random alloy In(0.4)Ga(0.6)As channel grown by molecular beam epitaxy (MBE). A new kinetic model was proposed and applied, which includes both group-III alkyl and group-V species in the surface chemical reactions, to the growth of GaAs, GaSb, and InAs by metalorganic MBE or chemical beam epitaxy (CBE). A gas source MBE system was set up with elemental group-III and doping sources as well as arsine and phosphine. The group-V limited growth mode was used to determine in situ the exact values of V/III atomic ratios during growth of GaP, InP, AlP, and GaAs. X ray studies of an InAlAs/InP superlattice indicates the existence of a P/As-intermixed, strained interface. GRA

**N91-17779#** Sandia National Labs., Albuquerque, NM.
**DEVELOPMENT OF INFRARED DETECTORS BASED ON TYPE 2, InAsSb STRAINED-LAYER SUPERLATTICES**
Steven R. Kurtz 1990 9 p Presented at the Fall Meeting of the Materials Research Society, Boston, MA, 24 Nov. - 1 Dec. 1990
(Contract DE-AC04-76DP-00789)
(DE91-004727; SAND-90-1698C; CONF-901105-28) Avail: NTIS HC/MF A02

An overview is provided of long wavelength, photovoltaic detectors constructed with Type 2 (also known as staggered), III-V superlattices. Specifically, the electronic properties of InAsSb strained-layer superlattices and prototype detectors utilizing these structures are described. DOE

**N91-17780#** Massachusetts Inst. of Tech., Cambridge. Dept. of Materials Science and Engineering.
**EFFECT OF GRAIN BOUNDARY STRUCTURE ON GRAIN BOUNDARY DIFFUSIVITIES IN THE Au/Ag SYSTEM**
Qing Ma and R. W. Balluffi 1 Dec. 1990 7 p
(Contract DE-FG02-87ER-45310)
(DE91-005785; DOE/ER-45310/22) Avail: NTIS HC/MF A02

Grain boundary chemical diffusivities for a series of symmetric (001) tilt boundaries in the Au/Ag system were measured by the surface accumulation method using newly developed thin-film multi-crystal specimens, in which the grain boundaries feeding the accumulation surface were all of the same type. Possible effects due to segregation at the grain boundaries and surfaces were

avoided. CSL boundaries of low-Sigma (i.e., 5, 13, 17, 25) and also more general boundaries with tilt angles between the low-Sigma orientations were selected. The diffusivities were found to vary monotonically with tilt angle (i.e., no cusps at low-Sigma's were found) in a manner consistent with the Structural Unit model. DOE

**N91-17781#** Sandia National Labs., Albuquerque, NM.
**LOW PRESSURE MOCVD GROWTH OF InSb**
B. T. Cunningham, R. P. Schneider, Jr., and R. M. Biefeld 1990 6 p Presented at the Fall Meeting of the Materials Research Society, Boston, MA, 24 Nov. - 1 Dec. 1990
(Contract DE-AC04-76DP-00789)
(DE91-005839; SAND-90-3159C; CONF-901105-55) Avail: NTIS HC/MF A02

Low pressure (200 Torr) metalorganic chemical vapor deposition (MOCVD) of InSb has been examined through variation of the Column 3 (TMIn) and Column 5 (TMSb or TESb) precursor partial pressures. The use of lower growth pressure significantly enhanced the range of allowable Column 3 Column 5 partial pressures in which specular morphology InSb could be obtained without the formation of In droplets or Sb crystals. In addition, a 70 percent improvement in the average hole mobility was obtained, compared to InSb grown in the same reactor at atmospheric pressure. SIMS analysis revealed that Si at the substrate/epitaxial layer interface is an important impurity that may contribute to degradation of the mobility. Substitution of TESb for TMSb did not result in any improvement in the purity of the InSb. DOE

**N91-17782#** Massachusetts Inst. of Tech., Cambridge. Dept. of Materials Science and Engineering.
**DIFFRACTION EFFECTS FROM (111) TWIST BOUNDARIES IN GOLD**
I. Majid, D. Wang, and P. D. Bristowe Dec. 1990 7 p
(Contract DE-FG02-87ER-45310)
(DE91-005849; DOE/ER-45310/23) Avail: NTIS HC/MF A02

The structural characteristics of (111) twist boundaries in gold are investigated using a combination of x ray diffraction and computer modeling techniques. Comparison of the measured scattering effects with those generated from EAM computer models reveals that the (111) boundary displacement field is weak, rotational in form and centered on O lattice sites. Furthermore, the measured intensities of the strong O lattice reflections decrease smoothly with increasing boundary angle up to 30 degrees, as calculated from the model. The effect of double positioning on the diffraction pattern and the structural analysis is discussed. DOE

**N91-17783#** Los Alamos National Lab., NM.
**ELASTIC AFTER-EFFECT DUE TO OXYGEN RELAXATION IN YBa2Cu3O(7-DELTA) ABOVE Tc**
J. R. Cost, P. E. Armstrong, R. B. Poeppel, and J. T. Stanley (Arizona State Univ., Tempe.) 1990 8 p Presented at the Fall Meeting of the Materials Research Society, Boston, MA, 25-30 Nov. 1990
(Contract W-7405-eng-36)
(DE91-005874; LA-UR-90-4292; CONF-901105-52) Avail: NTIS HC/MF A02

Isothermal elastic after-effect measurements to obtain relaxation times for the stress-induced motion of oxygen in YBa-2Cu3O(7-delta) have been made from 50 to 110 C. These results extend our previous internal friction measurements of the same oxygen relaxation to lower temperatures. The combined results, which cover nine orders of magnitude in relaxation time, show a classical Arrhenius temperature dependence, activation, energy Q=1.3 +/- 0.01 eV and attempt frequency tau(sub 0)=1.6 x 10(exp -13)s (log tau (sub 0) = -12.79 +/- 0.13). The mechanism of the relaxation is considered to be stress-induced ordering of oxygen atoms on the CuO basal plane. Diffusivities obtained from these results are compared with those from tracer diffusion of oxygen. DOE

**N91-17784#** Argonne National Lab., IL. Materials Science Div.
**PINNING IN TWIN BOUNDARIES OF YBa2Cu3O(7-DELTA) SINGLE CRYSTALS**
W. K. Kwok, U. Welp, K. G. Vandervoort, G. W. Crabtree, J. Z. Liu, J. Brooks, J. Hettinger, S. T. Hannahs, and S. Fleshler (Purdue Univ., West Lafayette, IN.) 1990 4 p Presented at the LT-19 Satellite Conference on High-Temperature Superconductivity, Cambridge, England, 13-15 Aug. 1990
(Contract W-31-109-eng-38; NSF STC-88-09854)
(DE91-006019; CONF-900817-3) Avail: NTIS HC/MF A01

We present direct observation of Lorentz force induced flux motion and pinning by twin boundaries in single crystal YBa2Cu3O(7-delta). From ac magnetoresistance measurements, we derive the effective pinning potential attributed to twin boundaries. DOE

**N91-17785#** Argonne National Lab., IL. Materials Science Div.
**CALCULATION OF DEFECT PROPERTIES OF NiTi AND FeTi**
Russell T. Lutton, Michael J. Sabochick (Air Force Inst. of Tech., Wright-Patterson AFB, OH.), and Nghi Q. Lam Dec. 1990 5 p Presented at the Fall Meeting of the Materials Research Society, Boston, MA, 26-30 Nov. 1990 Sponsored by AFIT
(Contract W-31-109-eng-38)
(DE91-006033; CONF-901105-57) Avail: NTIS HC/MF A01

The energies and configurations of interstitials and vacancies in the B2 ordered compounds NiTi and FeTi were calculated using atomistic simulation. The stable configuration of a vacancy after the removal of an Ni atom was a vacant Ni site; similarly, the removal of an Fe atom in FeTi resulted in a vacant Fe site. Removal of a Ti atom in both compounds, however, resulted in a vacant Ni or Fe site and an adjacent antisite defect. The effective vacancy formation energies in NiTi and FeTi were calculated to be 1.48 and 1.07 eV, respectively. Interstitials in NiTi formed split group zone axes (111) configurations consisting of a Ni-Ni dumbbell oriented in the group of zone axes (111) direction with one or two adjacent antisite defects. The Fe interstitial in FeTi had a similar configuration, except the dumbbell contained Fe atoms. The Ti interstitial in FeTi formed a group of zone axes (110) Fe-Fe dumbbell. DOE

**N91-17786#** Argonne National Lab., IL. Materials Science Div.
**TILT GRAIN BOUNDARIES IN YBa2Cu3O(7-x) THIN FILMS**
Y. Gao, G. Bai, H. L. M. Chang, K. L. Merkle, and D. J. Lam Jul. 1990 32 p Presented at the International Conference on Frontiers of Electron Microscopy, Oak Brook, IL, 20-24 May 1990
(Contract W-31-109-eng-38; NSF DMR-88-09854)
(DE91-006088; CONF-9005145-5) Avail: NTIS HC/MF A03

Grain boundaries in YBa2Cu3O(7-x) superconductor thin films grown on (001) MgO by metal-organic chemical vapor deposition (MOCVD) have been characterized using transmission electron microscopy (TEM) and high-resolution electron microscopy (HREM). It was found that the YBa2Cu3O(7-x) thin films were highly textured with the c axes, or (001) orientation, nearly parallel between grains and perpendicular to the MgO substrate. A majority of the grain boundaries are low-angle boundaries with a tilt angle, theta, less than 15 degrees. The low-angle boundaries appear to be strongly faceted on an atomic scale in such a way that the boundary planes tend to be parallel to the (100), (010), or (110) lattice planes in one of the adjacent grains. Almost all of the lattice planes, except for a number of distorted regions along the boundaries, are continuous across the boundaries from one grain to another, accommodating the misorientation with a slight bending of the lattice planes. The small-angle boundaries are shown to consist of arrays of dislocations. A domain structure, formed by the interchange of a and b axes has been observed in large grains. The domain boundaries are strongly faceted with the (100) and (010) lattice planes parallel to the boundaries. These observations on the atomic structure of boundaries, are used to discuss the effect of grain boundaries on superconductor properties in YBa2Cu3O(7-x) thin films. DOE

**N91-17787#** Argonne National Lab., IL. Chemistry Div.
**VIBRONIC INTERACTION AND CRYSTAL STRUCTURE DISTORTION IN Cm4(+):CeF4**
G. K. Liu, James V. Beitz, and W. T. Carnall 1990 12 p Presented at the 200th American Chemical Society National Meeting, Washington, DC, 26-31 Aug. 1990 Submitted for publication
(Contract W-31-109-eng-38)
(DE91-006093; CONF-900802-15) Avail: NTIS HC/MF A03

We have applied selective excitation to unravel the complex 5f state spectra of Cm(sup 4+) in CeF4 which arises from multiple metal ion sites and vibronic interactions. An unusual laser-induced site distortion on one of the two ion-sites has been studied. Distinct spectral lines of the distorted ion site were detected. The site distortion was found to be stable below 45 K and reverted, via a thermally activated process, at higher temperatures. Below 45 K, persistent spectral holes were burnt in the absorption lines of Cm(sup 4+) on distorted sites. Site distortion and hole burning are interpreted based on excited-state vibronic coupling and the assumption of an asymmetric two-minimum potential surface. DOE

**N91-17788#** Lawrence Livermore National Lab., CA.
**LASER CONDITIONING AND ELECTRONIC DEFECT MEASUREMENTS OF HfO2 AND SiO2 THIN FILMS**
M. R. Kozlowski, M. Staggs, F. Rainer, and J. H. Stathis (International Business Machines Corp., Yorktown Heights, NY.) 17 Dec. 1990 16 p Presented at the 22nd Boulder Damage Symposium, Boulder, CO, 24-26 Oct. 1990 Submitted for publication
(Contract W-7405-eng-48)
(DE91-006237; UCRL-JC-104883; CONF-9010287-2) Avail: NTIS HC/MF A03

Multilayer HfO2/SiO2 high reflectors (HR) and polarizers show a permanent increase in their 1064-nm damage thresholds following laser conditioning at subthreshold fluences. Threshold increases of 2-3x are typical. In an effort to better understand the conditioning effect we have made laser conditioning and electronic property measurements on single layers of these two materials. The laser damage threshold of 1-micron thick e-beam deposited SiO2 was increased by laser conditioning for wavelengths ranging from 355 to 1046 nm. The damage threshold of HfO2 single layers was not influenced by subthreshold illumination. As-deposited thin films of a-SiO2 are known to contain paramagnetic electronic defects. We have used electron paramagnetic resonance (EPR) to study the concentrations and types of defects present in single layer and multilayer films of HfO2 and SiO2. E(prime) and oxygen hole centers with concentrations on the order of 10(exp 17)/cc have been measured in the SiO2 layers. A previously unreported defect has been observed for HfO2. The concentration of defects was studied both before and after laser conditioning and damage with 1064-nm photons. These electronic structure measurements are discussed in relation to an electronic defect model for laser conditioning of dielectric multilayers. DOE

**N91-17789#** Midwest Research Inst., Golden, CO.
**RESEARCH ON POLYCRYSTALLINE THIN-FILM MATERIALS, CELLS, AND MODULES**
R. L. Mitchell, K. Zweibel, and H. S. Ullal Nov. 1990 9 p Presented at the 13th ASME-JSME International Solar Energy Conference, Reno, NV, 17-22 Mar. 1991
(Contract DE-AC02-83CH-10093)
(DE91-002124; SERI/TP-211-4061; CONF-910318-11) Avail: NTIS HC/MF A02

DOE supports research activities in polycrystalline thin films through the Polycrystalline Thin Film Program. This program includes includes R and D in both copper indium diselenide and cadmium telluride thin films for photovoltaic applications. The objective is to support R and D of photovoltaic cells and modules that meet the DOE long term goals of high efficiency (15 to 20 percent), low cost ($50/sq cm), and reliability (30-year life time). Research carried out in this area is receiving increased recognition due to important advances in polycrystalline thin film CuInSe2 and CdTe solar cells and modules. These have become the leading thin film materials for photovoltaics in terms of efficiency and stability. DOE has recognized this potential through a competitive initiative for the development of CuInSe(sub 2) and CdTe modules. The recent progress and future directions are studied of the Polycrystalline Thin Film Program and the status of the subcontracted research on these promising photovoltaic materials. DOE

**N91-17790#** Sandia National Labs., Albuquerque, NM. Device Research Div.
**STRAINED-LAYER ELECTRONICS AND OPTOELECTRONICS**
David R. Myers 1990 5 p Presented at the Picosecond Electronics and Optoelectronics Meeting, Salt Lake City, UT, 13-15 Mar. 1991
(Contract DE-AC04-76DP-00789)
(DE91-004505; SAND-90-3082C; CONF-910358-1) Avail: NTIS HC/MF A01

Strained-layer epitaxy involves more than the dislocation-free growth of dissimilar materials: effective strained-layer epitaxy exploits lattice-mismatch-induced strain to fine-tune material properties. This paper describes strained-layer epitaxy and describes its application to electronic and optoelectronic devices to improve performance. DOE

**N91-17791#** Oak Ridge National Lab., TN.
**RESONANT COHERENT EXCITATION OF Mg11(+): ELECTRONIC COLLISIONS OF STATE SPECIFIED SHORT-LIVED EXCITED STATES IN A CRYSTAL CHANNEL**
S. Datz, P. F. Dittner, J. GomezdelCampo, H. F. Krause, T. M. Rosseel, C. R. Vane, I. Iwata, I. Komaki, M. Kimura, and Y. Yamazaki (Tokyo Univ., Japan ) et al 1990 8 p Presented at the 13th Werner Brandt Workshop on the Interaction of Charged Particles with Matter, Nara, Japan, 16-18 Nov. 1990
(Contract DE-AC05-84OR-21400)
(DE91-006156; CONF-901188-1) Avail: NTIS HC/MF A02

Hydrogenic ions passing through axial and planar channels can be excited from n = 1 to n = 2 when the frequency of perturbation by the atoms in the crystal spaced a distance d apart comes into resonance with the spacing between eigenstates i and j, delta E(sub ij) = hK(v(sub i)/d), where K is a harmonic 1,2,3 ... of the (v(sub i)/d) frequency. The degeneracy in the n = 2 levels is removed initially by the asymmetry in the crystal field and then by Stark mixing of 2s with 2p(sub x) which is caused by the wake field. Thus, the resonant frequency, and hence velocity, for excitation to 2p(sub x,y) is different than that for 2p(sub x) and they can be excited selectively. In the present work we used Mg(11+), where the n = 2 ionization cross section is small enough to permit escape of some of the excited ions from the crystal without being ionized by subsequent collisions and with the subsequent emission of radiation. Since we can excite different orientations of the ion selectively by varying the velocity, we can measure the separate ionization cross sections for these states by determining the yields of totally stripped ions compared to those which emit a Ly alpha x ray. A comparison of the two channels shows that the probability of escape from the crystal without ionizations is greater for ions in the 2p(sub x) state than those in the 2p(sub x,y) state. These RCE data are presented as proof of principal for experiments which measure electron bombardment ionization cross sections for short lived excited states with specific polarization. DOE

**N91-17792#** Argonne National Lab., IL. Materials Science Div.
**IN SITU STUDY OF THE EFFECTS OF HEAVY-ION IRRADIATION ON CO-EVAPORATED CoSi2 FILMS**
Charles W. Allen and David A. Smith (International Business Machines Corp., Yorktown Heights, NY.) Nov. 1990 10 p Presented at the Fall Meeting of the Materials Research Society, Boston, MA, 25-30 Nov. 1990 Sponsored by IBM
(Contract W-31-109-eng-38)
(DE91-006419; CONF-901105-71) Avail: NTIS HC/MF A02

The in situ ion irradiation capability of Argonne's HVEM-Tandem User Facility has been employed to determine the effects of 1.5

MeV Kr(+) irradiation and 300 kV electron irradiation on the crystallization of as-deposited and of partially crystallized 40 nm thick films of CoSi2. Ion fluxes ranged from 8.5 x 10(exp 14) to 6.8 x 10(exp 15)/(sq m x s) for which beam heating effects may be neglected. The maximum electron flux at 300 kV was 0.8 x 10(exp 23)/(sq m x s) The maximum temperature at which crystalline CoSi2 is amorphized by the ion irradiation of flux = 6.8 x 10(exp 15)/(sq m x s) is between 250 and 280 K. At higher temperatures amorphous material crystallizes by growth of any preexisting crystals and by classical nucleation and growth, with radial growth rates which are proportional to ion flux. The average degree of transformation per ion is 4 x 10(exp -26) cubic meters/ion. Thermally induced crystallization of as-deposited films occurs above approximately 420 K. For ion doses at least as low as 3.4 (times) 10(sup 16) m(sup (minus)2) ion irradiation at 300 K promotes thermal crystallization at 450 K, by virtue of enhanced apparent nucleation and at large doses, by enhanced growth rate. DOE

**N91-17793#** Argonne National Lab., IL. Materials Science Div.
**IRRADIATION DEFECT STRUCTURES IN YBa2Cu3O(7-x) AND THEIR CORRELATION WITH SUPERCONDUCTING PROPERTIES**
Marquis A. Kirk Nov. 1990 11 p Presented at the Fall Meeting of the Materials Research Society, Boston, MA, 24 Nov. - 1 Dec. 1990
(Contract W-31-109-eng-38; NSF STC-88-09054)
(DE91-006420; CONF-901105-70) Avail: NTIS HC/MF A03

Irradiation effects in single crystal YBa2Cu3O(7-x) are reviewed. Transmission electron microscopy was employed to study the defect microstructures produced by irradiations with fast neutrons, MeV ions (Kr, Ne and p), and electrons. The atomic structure within defect cascades was investigated using 50 keV Kr and Xe ion irradiations to low doses. Evidence is shown for an amorphous structure with some incoherent recrystallization within individual cascades. Correlation with enhancements in critical current density produced by neutron irradiations suggest that this cascade structure effectively pins magnetic flux lines. At sufficiently high fluences of fast neutrons or MeV Kr and Ne ions, a cellular microstructure is found. This structure consists of cells or microcrystallites of good cystalline and superconducting material (in the case of neutron irradiation), with cell walls of amorphous material. Full amorphization proceeds with the growth of cell wall volume. The formation of this microstructure coincides with a decrease in critical transport current, but is not observed by magnetization measurements. Increases in critical current density under proton irradiation, comparable to those produced by neutron irradiation, have been reported. The defect structure produced by proton irradiations is examined and found to differ from that of neutron irradiations. The most recent measurements of changes in critical temperature and current density, and defect microstructure following electron irradiations are described. DOE

**N91-17794#** Argonne National Lab., IL. Materials Science Div.
**CHARACTERIZATION OF NANOCRYSTALLINE Pd BY X RAY DIFFRACTION AND EXAFS**
J. A. Eastman, M. R. Fitzsimmons, M. Mueller-Stach, G. Wallner, and W. T. Elam (Naval Research Lab., Washington, DC.) Dec. 1990 7 p Presented at the Acta Metallurgical Conference on Materials with Ultrafine Microstructures, Atlantic City, NJ, 1-5 Oct. 1990 Sponsored in part by American-German Fulbright Commission and BFMT
(Contract W-31-109-eng-38)
(DE91-006441; CONF-9010292-3) Avail: NTIS HC/MF A02

Since the fraction of atoms located within a few atomic distances of one or more internal interfaces increases rapidly with decreasing grain size in the nanometer regime, it is expected that the structure of grain boundaries plays an important role in determining and controlling the properties of nanocrystalline materials. A high resolution electron microscopy study of nanocrystalline Pd found no evidence for extended, disordered boundary regions that would differ from boundaries in coarse-grained materials. Recent results from x ray diffraction, EXAFS and hydriding studies have yielded clear evidence that the boundaries in nanocrystalline Pd are ordered and/or extremely localized in nature. The present paper will summarize and discuss the principal results of these three studies. DOE

**N91-17795#** Argonne National Lab., IL. Chemistry Div.
**A REVIEW OF BASIC PHENOMENA AND TECHNIQUES FOR SPUTTER-DEPOSITION OF HIGH TEMPERATURE SUPERCONDUCTING FILMS**
O. Auciello, M. S. Ameen, A. I. Kingon, D. J. Lichtenwalner (North Carolina State Univ., Raleigh.), and A. R. Krauss 1990 34 p Presented at the 4th International Conference on Surface Modification Technologies, Paris, France, 6-9 Nov. 1990
(Contracts W-31-109-eng-38; DE-FG05-88ER-45359)
(DE91-006468; CONF-9011108-1) Avail: NTIS HC/MF A03

The processes involved in plasma and ion beam sputter-deposition of high temperature superconducting thin films are critically reviewed. Recent advances in the development of these techniques are discussed in relation to basic physical phenomena, specific to each technique, which must be understood before high quality films can be produced. Control of film composition is a major issue in sputter-deposition of multicomponent materials. Low temperature processing of films is a common goal for each technique, particularly in relation to integrating high temperature superconducting films with the current microelectronics technology. It has been understood for some time that for Y1, Ba2, Cu3, O7 deposition, the most intensely studied high-(Tc) compound, incorporation of sufficient oxygen into the film during deposition is necessary to produce as-deposited superconducting films at relatively substrate temperatures. Recent results have shown that with the use of suitable buffer layers, high quality Y1, Ba2, Cu3, O7, sputtered films can be obtained on Si substrates without the need for post-deposition anneal processing. This review is mainly focussed on issues related to sputter-deposition of Y1, Ba2, Cu3, O, thin films, although representative results concerning the bismuth and thallium based compounds are included. DOE

**N91-17796#** Argonne National Lab., IL.
**PROCESSING AND FABRICATION OF YBa2Cu3O(x)/Ag COMPOSITE WIRES AND COILS**
W. A. Ferrando, A. P. Divecha, A. N. Mansour, S. D. Karmarkar (Naval Surface Weapons Center, Silver Spring, MD.), U. Balachandran, S. E. Dorris, J. T. Dusek, J. J. Picciolo, J. P. Singh, and R. B. Poeppel Nov. 1990 16 p Presented at the 2nd International Ceramic Science and Technology Congress, Orlando, FL, 12-15 Nov. 1990 Submitted for publication Sponsored by NSWC; ONR; and NRL
(Contract W-31-109-eng-38)
(DE91-006532; CONF-901125-8) Avail: NTIS HC/MF A03

Silver was added to YBa2Cu3O(x) (123) powder by a melt technique using AgNO3 and heated to approx. 600 C to decompose the nitrate. This process yields 123 powder that is uniformly coated with Ag, as indicated by optical and scanning electron microscopy (SEM). The composite power is formed into rods (approx. 4 mm diameter) via drawing and swaging through conical converging dies. Wires of finer diameter (approx. 1 mm) and substantially greater linear uniformity were produced by slurry extrusion of the composite powder in a polymeric vehicle. Transport critical current density, J sub c, of these wires at present is about 750 A/sq cm. This value may be expected to rise due to further reduction of second phase impurities localized at grain boundaries and better understanding of the Ag/superconductor interface. The wire fabrication is described in some detail and discusses the results of microscopic analyses by scanning electron microscopy (SEM), x ray photoemission spectroscopy (XPS), and x ray diffraction (XRD). DOE

**N91-17797#** Argonne National Lab., IL. Materials Science Div.
**ELECTRON MICROSCOPY STUDY OF MOCVD-GROWN TiO2 THIN FILMS AND TiO2/Al2O3 INTERFACES**
Y. Gao, K. L. Merkle, H. L. M. Chang, T. J. Zhang, and D. J. Lam Nov. 1990 7 p Presented at the Fall Meeting of the Materials

Research Society, Boston, MA, 26 Nov. - 1 Dec. 1990
(Contract W-31-109-eng-38)
(DE91-006544; CONF-901105-68) Avail: NTIS HC/MF A02

TiO2 thin films grown on (11(bar 2)0) sapphire at 800 C by the MOCVD technique were characterized by transmission electron microscopy. The TiO2 thin films are single crystalline and have the rutile structure. The epitaxial orientation relationship between the TiO2 thin films (R) and the substrate (S) was found. Growth twins in the films are commonly observed with the twin plane and twinning direction. Detailed atomic structures of the twin boundaries and TiO2/alpha-Al2O3 interfaces were investigated by high resolution electron microscopy (HREM). When the interfaces are viewed in the direction of /0(bar 1)0/sub R/0001/sub S, the interfaces are found to be structurally coherent in the direction of /(bar 1)01/sub R/1(bar 1)00/sub S, in which the lattice mismatch at the interfaces is about 0.5 percent. DOE

**N91-17798#** Argonne National Lab., IL. Materials Science Div.
**IN SITU STUDY OF EFFECTS OF ION-IRRADIATION ON SOLID STATE CRYSTALLIZATION OF COBALT DISILICIDE THIN FILMS**
Charles W. Allen and David A. Smith (International Business Machines Corp., Yorktown Heights, NY.) 1990 16 p Presented at the Symposium on New Directions and Future Aspects of HVEM, Osaka, Japan, 8-10 Nov. 1990 Submitted for publication
Sponsored in part by IBM
(Contract W-31-109-eng-38)
(DE91-006547; CONF-9011166-1) Avail: NTIS HC/MF A03

Results of a continuing in situ study of the ion irradiation modified crystallization of amorphous CoSi2 thin films are discussed. A 1.5 MeV Kr ion irradiation is employed at 90 K to mix nominally amorphous, as-deposited material for subsequent epitaxial regrowth at 450 K. The ion irradiation also is employed at 300 K to produce ion-assisted crystallization. The average degree of transformation per ion is approximately 4 x 10(exp -20) cu cm per ion. The resultant number density of crystals, however, depends sensitively on prior treatment of the film. For example, 300 kV electron irradiation at 300 K prior to ion irradiation may result in a large number density of crystal nuclei. Low dose Kr irradiation at 300 K may also cause a slight increase in the number density of crystals formed subsequently at 450 K, while large Kr doses at 300 K (greater than 3 x 10(exp 14)/sq cm) may double the subsequent thermal growth rate at 450 K. These results are discussed qualitatively in terms of nucleation and growth theory. DOE

**N91-17799#** Argonne National Lab., IL.
**THERMOMECHANICAL PROCESSING OF YBa2Cu3O(x)/Ag SHEATHED WIRES M.S. Thesis - Univ. of Illinois**
M. J. McGuire, S. Danyluk, K. C. Goretta, M. T. Lanagan, U. Balachandran, and R. B. Poeppel Nov. 1990 13 p Presented at the 2nd International Ceramic Science and Technology Congress, Orlando, FL, 12-15 Nov. 1990 Prepared in cooperation with Illinois Univ., Chicago
(Contract W-31-109-eng-38)
(DE91-006548; CONF-901125-7) Avail: NTIS HC/MF A03

Silver-sheathed YBa2Cu3O(x) (YBCO) powder was thermomechanically processed by rolling wire into flat tapes from sealed 6.3 mm diameter, 76 mm long billets. Transport J(sub c) values at 77 K in zero applied magnetic filed reached about 600 A/sq cm. Mechanical processing of powder-in-tube specimens involves fracture, densification, and sliding of powder particles as well as deformation and work hardening of the metallic sheath. A model of these effects was developed and the experimental results suggest that the deformation properties of the powder dominate the stresses to fabricate the tapes. DOE

**N91-17800#** Argonne National Lab., IL.
**CHARACTERIZATION OF COMPOSITE HIGH TEMPERATURE SUPERCONDUCTORS FOR MAGNETIC BEARING APPLICATIONS**
B. R. Weinberger, L. Lynds, J. VanValzah, H. Eaton, J. R. Hull, T. M. Mulcahy, and S. A. Basinger 1990 28 p Presented at the Applied Superconductivity Conference, Aspen, CO, 24-28 Sep. 1990 Prepared in cooperation with United Technologies Research Center, East Hartford, CT Submitted for publication
(Contract W-31-109-eng-38)
(DE91-006552; CONF-900944-31) Avail: NTIS HC/MF A03

A study of high temperature superconductor composites for use in magnetic bearings applications is presented. Fabrication and characterization techniques are described. Magnetometry and mechanical force measurements are correlated with a particular emphasis on the role of superconductor particle size. Results are discussed in terms of fundamental limits of Meissner effect levitation. DOE

**N91-17801#** Argonne National Lab., IL. Materials Science Div.
**MECHANISMS CONTROLLING THE IN-SITU FORMATION AND SUPERCONDUCTING PROPERTIES OF Bi-Sr-Ca-Cu-O FILMS**
R. T. Kampwirth, J. M. Grace, D. J. Miller, D. B. McDonald, K. E. Gray, M. Reiten, M. Ascolese, and H. Latvakoski 1990 5 p Presented at the Applied Superconductivity Conference, Aspen, CO, 24-28 Sep. 1990 Submitted for publication
(Contract W-31-109-eng-38; NSF STC-88-09854)
(DE91-006559; CONF-900944-34) Avail: NTIS HC/MF A01

We have previously shown that sputtered films of Bi2Sr2CaCu2O(x) (BSCCO) deposited onto single crystal MgO substrates held at substrate temperatures, T(sub s), near 700 C and slowly cooled in oxygen, from High Temperature Superconducting (HTS) films with T(sub c zero) between 50 and 70 K. The conditions necessary to achieve superconductivity include having close to stoichiometric composition at the T(sub s) required to form the superconductor. Both T(sub c zero) and c-axis orientation increase with T(sub s) while the relative bismuth content decreases. Bismuth film content is affected by the type and amount of oxidant, total system pressure, target-to-substrate spacing, and substrate bias. We suggest oxygen resputtering of the film may play a role similar to the reported for YBa2Cu3O(7-x) (YBCO). Oxygen partial pressure during and cool down rate from T(sub s) to approximately 350 C also affects the superconducting properties. DOE

**N91-17802#** Argonne National Lab., IL.
**TEXTURE ANALYSIS OF BULK YBa2Cu3O(x) BY NEUTRON DIFFRACTION Ph.D. Thesis Illinois Inst. of Technology, Chicago**
J. S. Kallend (Illinois Inst. of Tech., Chicago.), A. C. Biondo, A. J. Schultz, and K. C. Goretta Sep. 1990 10 p Presented at the 2nd World Congress on Superconductivity, Houston, TX, 10-13 Sep. 1990 Submitted for publication
(Contract W-31-109-eng-38; NSF STC-88-09854)
(DE91-006563; CONF-900910-2) Avail: NTIS HC/MF A02

Neutron diffraction has been used to generate Orientation Distribution Functions for two sinter-forged YBa2Cu3O(x) specimens. Sinter forging imparted a strong texture, with c axes of crystals preferentially aligned parallel to the forging direction. The distribution of a and b axes was not uniform, which may have implications to critical current density. DOE

**N91-17803#** Argonne National Lab., IL.
**CONTROL OF YBa2Cu3O(7-x) DEGRADATION DURING HEAT TREATMENT**
S. E. Dorris, R. B. Poeppel, J. J. Picciolo, U. Balachandran, M. T. Lanagan, C. Z. Zhang, K. L. Merkle, Y. Gao, J. T. Dusek, and H. E. Jordan (Reliance Electric and Engineering Co., Cleveland, OH.) et al Oct. 1990 13 p Presented at the 2nd World Congress on Superconductivity, Houston, TX, 10-13 Sep. 1990
(Contract W-31-109-eng-38; NSF DMR-88-09854)
(DE91-006564; CONF-900910-3) Avail: NTIS HC/MF A03

The importance of closely controlling the furnace atmosphere during processing of YBa2Cu3O(7-x) (YBCO) was examined. The stability of YBCO during sintering was studied as a function of CO2 partial pressure in CO2/O2 gas mixtures. The zero-field critical current density, J(sub c), decreased with increasing CO2 partial pressure, and ultimately reached zero, even though Meissner effect measurements showed that the bulk of the samples with zero transport J(sub c) remained superconducting. Examination of the

microstructure and composition of the samples by TEM, AEM, and SIMS showed the presence of BaCuO2 and BaCu2O2 at a minority of the grain boundaries. Near other grain boundaries, where second phases were not readily evident, the structure was found to be tetragonal for several tens of nm up to the grain boundaries, whereas the grain interiors were found to be orthorhombic. At high partial pressures of CO2, YBCO completely decomposed to BaCO3, Y2BaCuO5 (211), and CuO. In the firing of plastically processed superconductors, such as extruded YBCO coils, it was found that the use of reduced total pressure prevents the decomposition of YBCO. DOE

**N91-17804#** Argonne National Lab., IL. Materials and Components Technology Div.
**DEGRADATION OF PROPERTIES OF YBa2Cu3O(x) SUPERCONDUCTORS SINTERED IN CO2-CONTAINING ATMOSPHERE**
U. Balachandran, C. Z. Zhang, D. Xu, Y. Gao, K. L. Merkle, J. N. Mundy, B. W. Veal, R. B. Poeppel, G. Selvaduray, and T. O. Mason (Northwestern Univ., Evanston, IL.) Sep. 1990 10 p Presented at the 4th Annual Conference on Superconductivity and its Applications, Buffalo, NY, 18-20 Sep. 1990 Submitted for publication
(Contract W-31-109-eng-38; NSF DMR-88-09854)
(DE91-006569; CONF-900990-2) Avail: NTIS HC/MF A02

Stability of the YBa2Cu3O(x) (YBCO) superconductor toward reacting with CO2 in CO2/O2 gas mixtures during sintering was investigated as a function of the partial pressure of CO2 and temperature. The transport critical current density, J sub c, of the superconductor decreased drastically with increasing partial pressure of CO2 was increased, J sub c became zero (at 77 K) even though the major phase of the sample was still a superconductor as determined by magnetic susceptibility measurements. Microstructures and compositions of the samples were investigated by transmission electron microscopy in conjunction with energy-dispersive x ray spectroscopy. Two types of grain boundaries were observed: approx. 10 percent of the grain boundaries contained a second phase; the regions near the remaining grain boundaries were tetragonal. At high partial pressures of CO2, the YBCO completely decomposed to BaCO3, Y2BaCuO5, and CuO. DOE

**N91-17805#** Argonne National Lab., IL. Materials and Components Technology Div.
**ATMOSPHERE CONTROL DURING PREPARATION OF YBa2 Cu3O(7-x) MAGNET WINDINGS**
R. B. Poeppel, S. E. Dorris, J. J. Picciolo, U. Balachandran, M. T. Lanagan, C. Z. Zhang, K. L. Merkle, Y. Gao, and J. T. Dusek Oct. 1990 5 p Presented at the 3rd International Symposium on Superconductivity, Sendai, Japan, 6-9 Nov. 1990
(Contract W-31-109-eng-38; NSF DMR-88-09854)
(DE91-006570; CONF-901169-6) Avail: NTIS HC/MF A01

Large coils of YBa2Cu3O(7-x) can be fired successfully if the furnace atmosphere is carefully controlled. Organics added during processing produce CO2 during the initial portions of the firing schedule. Transmission electron microscopy of material fired in atmospheres containing various levels of CO2 clearly shows the extent of grain boundary degradation caused by CO2. Coils with acceptable critical current density can be produced if the rate of CO2 removal is adequate. DOE

**N91-17806#** Argonne National Lab., IL.
**TUNNELING SPECTROSCOPY MEASUREMENTS ON LOW-LEAKAGE JUNCTIONS OF Nd(1.85)Ce(0.15)CuO(4-y) AND Ba(1-x)K(x)BiO3**
J. F. Zasadzinski, N. Tralshawala (Illinois Inst. of Tech., Chicago.), Qiang Huang, K. E. Gray, and D. G. Hinks 1990 5 p Presented at the Applied Superconductivity Conference, Aspen, CO, 24-28 Sep. 1990 Submitted for publication
(Contract W-31-109-eng-38; NSF STC-88-09854)
(DE91-006585; CONF-900944-29) Avail: NTIS HC/MF A01

Tunneling measurements are reported for Nd(1.85)Ce-(0.15)CuO(4-y) (NCCO) and Ba(1-x)K(x)BiO3 (BKBO) using the point-contact technique with a Au or Nb tip. The junctions display very low zero-bias conductance values of less than 1 percent for BKBO and approx. 10 percent for NCCO, and show sharp conductance peaks at eV = + or - Delta. In the case of BKBO, the normalized conductance can be fit with a BCS density of states with thermal smearing only. The energy gaps are in good agreement with optical measurements and lead to values of 2Delta(k)(Tc) in the range of 3.5 to 4.0 for both compounds implying moderate coupling strength. The tunneling conductance data at high bias voltages display reproducible structures which are characteristic of phonon effects as found in conventional superconductors. The Eliashberg functions was obtained, alpha(exp 2)F(omega), and the resulting values of lambda determined from this analysis are consistent with the measured values of the strong-coupling ratio, 2Delta/k(Tc). It is concluded that the pairing mechanism in both materials is principally phonon mediated. DOE

**N91-17807#** Argonne National Lab., IL. Materials Science Div.
**CRITICAL CURRENTS, MAGNETIC RELAXATION, AND MICROSTRUCTURE IN ZONE-MELTED YBa2Cu3O(x)**
Donglu Shi, J. G. Chen, Ming Xu, K. C. Goretta, P. J. McGinn, and W. H. Chen (Notre Dame Univ., IN.) 1990 4 p Presented at the Applied Superconductivity Conference, Aspen, CO, 24-28 Sep. 1990 Submitted for publication Sponsored in part by Indiana Corp. for Science and Technology
(Contract W-31-109-eng-38; NSF MSM-87-1843)
(DE91-006594; CONF-900944-36) Avail: NTIS HC/MF A01

Extruded YBa2Cu3O(x) wires were zone melted to develop highly textured microstructures. The zone melted wires exhibit large magnetic hysteresis and transport J sub c values relative to conventional bulk YBa2Cu3O(x). Transmission electron microscopy observations indicate unique grain boundary features which are likely to be responsible for reduced weak-link effects. Large amounts of intragranular defects such as dislocations and Y2BaCuO5 particles were observed in the sample matrices. The dislocations are possibly connected with the greatly increased magnetic hysteresis. DOE

**N91-17808#** Argonne National Lab., IL. Materials Science Div.
**DISSIPATION IN HIGH-TEMPERATURE SUPERCONDUCTORS IN A MAGNETIC FIELD**
D. H. Kim, K. E. Gray, R. T. Kampwirth, D. B. McDonald, and D. M. McKay 1990 5 p Presented at the Applied Superconductivity Conference, Aspen, CO, 24-28 Sep. 1990 Submitted for publication
(Contract W-31-109-eng-38; NSF STC-88-09854)
(DE91-006596; CONF-900944-32) Avail: NTIS HC/MF A01

The absence of a Lorentz force dependence on dissipation in the highly anisotropic highly high temperature superconductor, Tl2Ba2CaCu2O(x), was measured over a wide range of current densities in broadened resistive transitions, current-voltage characteristics, magnetoresistances, and critical current densities, J sub c. The magnetoresistances are very useful to find out the correct temperature and field dependences of the activation energy. As an alternative to flux motion, a Josephson coupling model was considered which is consistent with the broadened resistive transitions and the lack of Lorentz force dependence. It was found that the Josephson coupling model agrees with the temperature dependences of the activation energy and J sub c and is better matched to the weak field dependence of J sub c than the flux creep model. Possible origins of Josephson junctions in high quality films and single crystals are discussed. DOE

# 77 THERMODYNAMICS AND STATISTICAL PHYSICS

Includes quantum mechanics; theoretical physics; and Bose and Fermi statistics.

For related information see also *25 Inorganic and Physical Chemistry* and *34 Fluid Mechanics and Heat Transfer.*

**N91-17809#** State Univ. of New York, Buffalo. Dept. of Chemistry.
**ESCAPE TIME FROM A BIASED ASYMMETRIC DOUBLE QUANTUM WELL**
Lakshmi N. Pandey and Thomas F. George Nov. 1990 17 p Submitted for publication
(Contract N00014-90-J-1193)
(AD-A229289; TR-30) Avail: NTIS HC/MF A03 CSCL 20/10

The escape time from the quasibound states of an asymmetrical structure consisting of a narrow well and a wide well separated by a relatively thick barrier under bias has been calculated. As expected, a monotonic decrease in the escape time from the ground state of the wide well as a function of applied voltage has been found. However, the variation of the escape times from the ground state of the narrow well and the first-excited state of the wide well versus applied voltage form a minimum at a common point. This is the signature of resonant tunneling when these two states almost coincide. GRA

**N91-17810#** Los Alamos National Lab., NM.
**A GENERIC MODEL FOR THE IONIC CONTRIBUTION TO THE EQUATION OF STATE**
J. D. Johnson Jan. 1991 15 p
(Contract W-7405-eng-36)
(DE91-006011; LA-12003-MS) Avail: NTIS HC/MF A03

We have formulated a model that yields the thermodynamics for the ionic contribution to general materials from the low temperature solid region, through melting, to ideal gas. We use the Debye model for the solid. Melting is determined by the Lindemann formula with standard rules of thumb used to determine density and energy discontinuities. The model interpolates through the liquid regime to ideal gas assuming that the specific heat drops monotonically from about 3R at melting, to 9R/4 at five times melting, and continuing to 3R/2 at high temperatures. The area under the specific heat curve is constrained in the model to reproduce the correct high temperature entropy. Thus, for a compound, the extra contribution from the entropy of mixing forces into the model is, in a crude way, the extra specific heat due to dissociation. DOE

# 80 SOCIAL SCIENCES (GENERAL)

Includes educational matters.

No abstracts in this category.

# 81 ADMINISTRATION AND MANAGEMENT

Includes management planning and research.

**N91-17811#** National Science Foundation, Washington, DC. Div. of Science Resources Studies.
**NATIONAL PATTERNS OF R AND D RESOURCES: 1990 Final Report**
J. E. Jankowski Apr. 1990 73 p
(PB90-259839; NSF-90-316) Avail: NTIS HC/MF A04 CSCL 05A

The subject areas covered are: general notes to the reader; highlights; trends in national R and D support; measures and comparisons of national resources for R and D; national R and D performance patterns - by sector; national R and D performance patterns - by state; character of work; R and D scientists and engineers; and appendixes. Author

**N91-17051*#** Lockheed Missiles and Space Co., Sunnyvale, CA.
**RISK ANALYSIS AND MANAGEMENT**
H. E. Smith *In* NASA, Washington, Space Transportation Avionics Technology Symposium. Volume 2: Conference Proceedigs Aug. 1990 p 687-694 (For primary document see N91-17020 09-06)
Avail: NTIS HC/MF A99 CSCL 05A

# 82 DOCUMENTATION AND INFORMATION SCIENCE

Includes information management; information storage and retrieval technology; technical writing; graphic arts; and micrography.

For computer documentation see *61 Computer Programming and Software.*

**N91-17812#** Virginia Polytechnic Inst. and State Univ., Blacksburg. Management Systems Labs.
**RESEARCH AND DEVELOPMENT OF MODELS AND INSTRUMENTS TO DEFINE, MEASURE, AND IMPROVE SHARED INFORMATION PROCESSING WITHIN GOVERNMENT OVERSIGHT AGENCIES. VOLUME 1: RESEARCH STATUS Annual Report No. 4, Aug. 1989 - Jul. 1990**
1990 196 p
(Contract DE-FG05-86DP-70033)
(DE90-009989; DOE/DP-70033/4-VOL-1) Avail: NTIS HC/MF A10

Plans to study is at the very forefront of information systems and management research. The first phase of the research objective is exploratory. Exploratory research is longitudinal. During this phase of research, we form objectives, construct qualitative models, emphasize defining relationships and comparisons, make observations to draw implications, corroborate findings, and define directions. The second and third phases are confirmatory. Confirmatory research is cross-sectional. Through confirmatory research we form hypotheses, construct quantitative models, emphasize measurement and evaluation, set up and run experiments, verify results, and draw conclusions. This annual performance report describes the previous years' research efforts and the plan for the upcoming year. DOE

**N91-17813#** National Lab. for High Energy Physics, Ibaraki (Japan).
**PROCEEDINGS OF THE SYMPOSIUM ON NETWORKING**
Yukio Karita, ed. and Fumio Abe, ed. Jun. 1989 306 p Presented at the 1st Symposium on Networking, Tsukuba, Japan, 6-7 Feb. 1989
(DE90-777889; KEK-89-3; CONF-8902176) Avail: NTIS (US Sales Only) HC A14

The first symposium on networking was held on February 6 to 7, 1989. Due to the increase of the needs of computer networks, several networks which connect among universities and laboratories are going to be constructed in Japan. However, the techniques in networking are not familiar to most people, and the information about these techniques is sometimes difficult to get, especially in multivendor connection. In such a situation, an opportunity to hold a symposium on networking at the National Laboratory for High Energy Physics (KEK) was given. More than 200 people took part in this symposium, and the local area networks in institutions, the networks among institutions, the networks for high energy physics, the application of networks, the networks for academic research and so on are reported. The valuable discussion about networks was carried out, including the plans for near future. At the time of this symposium, the construction of the Gakujo-net and the Pacific network project of University of Hawaii were in

progress, and many Japanese universities are going to construct their campus LANs, so the symposium seemed to be very timely.
DOE

**N91-17814** Arizona State Univ., Tempe.
**THE DESIGN, DEVELOPMENT, AND EVALUATION OF AN EXTENDED RELATIONAL DATABASE ARCHITECTURE FOR ELECTRONIC MEETING SYSTEMS Ph.D. Thesis**
Stephen French Richards, Jr. 1989 226 p
Avail: Univ. Microfilms Order No. DA9018524

Recent research in the application of computerized information technology to group decision and communication support has led to proposals for the development of electronic meeting systems (EMS). These systems are intended to provide comprehensive and integrated support for groups performing a wide range of decision and communication tasks in a variety of settings. To support the development of EMS, the concept of a Group Operating System (GOS) is advanced. A GOS provides the database, user interface, and system control facilities that enables the user group to establish and enforce their agenda, interact with the decision software tools, communicate with one another, and store their intermediate and final work products. The literature on Group Decision Support Systems, Computer-Mediated Communication Systems, and Computer-Based Systems for Cooperative Work is integrated to develop specific operational requirements for future EMS architectures. Further, it maps this architecture onto an extended relational database management system using extensions to the relational database paradigm currently proposed in the computer science discipline. These extensions include the ability to store queries and procedure calls as data elements and to return the results of evaluating these elements when accessing the database. A prototype GOS implemented using the proposed design is described. This prototype was evaluated by the specified operational requirements for the practicality and usefulness of the architecture and its extended relational database implementation.
Dissert. Abstr.

**N91-17815** Brunel Univ., Uxbridge (England).
**AN ASSOCIATIVE TEXT FILTER FOR MICROCOMPUTER-BASED DOCUMENT RETRIEVAL Ph.D. Thesis**
Silvano Piedade Vena Barros 1983 430 p
Avail: Univ. Microfilms Order No. BRDX89881

Existing methodologies highlighting their relative merits and weaknesses are reviewed. The basis for the specification of a low-cost fast, in-line text engine for retrieval (FILTER) based retrieval system is provided which employs an associative parallel processor (APP) for efficient character string matching. The resultant retrieval model features three concurrent processes which scans document text to eliminate intermediate indexes, and searches on-the-fly to minimize retrieval times. Hence this approach makes possible: (1) flexible access capabilities; (2) reduction in file storage (hardware) and maintenance (software) overheads; and (3) simplified data base organization, permitting fast update. The experimental investigation was conducted in two phases. In phase 1, the internal architecture and the retrieval algorithms for the FILTER were tested by simulation. The results obtained indicate that the design is fundamentally viable and capable of operating at a wide range of disk transfer speeds. Phase 2 tested the conceptual operation of the FILTER retrieval model by implementation. The model is implementation independent, and in the absence of usable APP hardware, a commercially available associative processor called recognition memory (REM), was used to aid the implementation. This confirmed that the model is both functionally and economically realizable. These experiments indicated that special hardware can be minimized by suitable partitioning of the FILTER based retrieval model, while retrieving at speeds in the range 0.23 to 0.95 Mbytes/second (worst case). This is comparable to substantially more costly systems currently under development. Hence, it is concluded that a low-cost microcomputer based document retrieval system is well within the scope of the requirements for the personal applications environment.
Dissert. Abstr.

**N91-17816** Aston Univ., Birmingham (England).
**THE IMPLEMENTATION OF A FUNCTIONAL QUERY LANGUAGE FRONT-END TO A RELATIONAL DATABASE SYSTEM, VOLUMES 1 AND 2 Ph.D. Thesis**
Hanifa Unisa Shah 1989 501 p
Avail: Univ. Microfilms Order No. BRDX89646

One of the components of a database systems user interface will normally be a query language which is based on a particular data model. Typically, data models provide primitives to define, manipulate, and query databases. Often these primitives are designed to form self-contained query languages. A prototype implementation of a system is described which allows users to specify queries against the database in a query language whose primitives are not those provided by the actual model on which the database system is based, but those provided by a different data model. The implementation chosen is the functional query language front end (FQLFE). This uses the Daplex functional data model and query language. Using FQLFE, users can specify the underlying database (based on the relational model) in terms of Daplex. Queries against this specified view can then be made in Daplex. FQLFE transforms these queries into the query language (QUEL) of the underlying target database system. The automation of part of the Daplex function definition phase is also described and its implementation discussed.
Dissert. Abstr.

**N91-17817** Illinois Inst. of Tech., Chicago.
**A MICROCOMPUTER-BASED INFORMATION RETRIEVAL SYSTEM WITH RELATIONAL THESAURI TO SUPPORT A MEDICAL EXPERT SYSTEM Ph.D. Thesis**
Guang-Nay Wang 1989 124 p
Avail: Univ. Microfilms Order No. DA9027323

LITREF is an online bibliographic retrieval system. It supports the stroke consultant MAIESTRO, an expert system for the diagnosis and management of stroke cases. This expert system is a joint project of the Department of Neurology at Michael Reese Hospital and the Department of Computer Science at Illinois Institute of Technology. LITREF interprets a Boolean command language to provide fast, efficient browsing of abstracts from the stroke literature. User feedback on keywords derived from a relational thesaurus is used to enhance the original query. Response time is immediate when LITREF runs on an IBM PC/AT microcomputer. The user-friendly online help facilitates users access to the system. It was enthusiastically received by users at its initial trial. The system design uses an inverted file structure with a bitmap strategy to speed access to retrieval objects. The implementation uses MS-QUICK C under DOS 3.1. It runs on any IBM compatible PC with a hard disk. The database contains 597 abstracts in the area of cerebral infarction and cerebral hemorrhage from 1983 to 1988 and occupies 1.6 Megabytes of storage. Three index files take 42 Kbytes of memory. The cosine function is used to measure the similarity between a query and an abstract. Recall and precision are used in the evaluation of retrieval effectiveness. Two experiments were performed using LITREF as a testbed. One experiment involves applying alternative suffixing algorithms to both index terms and query keywords. When the results are evaluated by comparing precision values at each recall level the word stem index method was found to be superior to the full work index method. The other experiment is a test of whether a relational thesaurus extracted from a large lexicon with lexical and semantic relations from Webster's Seventh New Collegiate Dictionary can actually improve retrieval effectiveness. The initial test using binary weighting in a batch run obtained a negative result.
Dissert. Abstr.

**N91-17818** Florida Univ., Gainesville.
**A STRUCTURE-FUNCTION MODELING PARADIGM FOR ENGINEERING DATABASES Ph.D. Thesis**
Aloysius Cornelio 1989 208 p
Avail: Univ. Microfilms Order No. DA9028505

A unifying data representation structure-function paradigm is proposed for modeling and integrating engineering systems. This paradigm consists of structural information, functional infromation, and interactions between structures and functions. Structural

information models the physical system, physical constraints, and the system state, whereas functional information models the overall behavior of the system. Well-defined interactions model the many-to-many semantic associations between the structural and the functional information. The structure-function paradigm uses object-oriented concepts where the structures are represented by structural objects, the functions are represented by functional objects, and the interactions between structures and functions are represented by interaction objects. This paradigm is based on the premise that structural and functional models of inherently complex natural and man-made systems are not isomorphic. Invariants ensure that the structural objects and the functional objects are abstracted correctly. A set of rules for preserving the integrity and correctness of composite structural objects and composite functional objects are presented. The proposed representation also supports an active database environment by modeling events which monitor input data and system state, and initiate and terminate actions. These events trigger a set of constraints to ensure the consistency of the system representation, thus making this paradigm suitable for monitoring and simulating applications. The utility of this paradigm is demonstrated in two areas: (1) discrete manufacturing for building robotic workcells; and (2) computer integrated manufacturing to integrate engineering databases with operational information. Dissert. Abstr.

**N91-17819#** Executive Office of the President, Washington, DC.
**PUBLICATIONS OF THE EXECUTIVE OFFICE OF THE PRESIDENT, JANUARY 20, 1989 - SEPTEMBER 30, 1990**
1990 6 p
(PB90-237652) Avail: NTIS HC/MF A02 CSCL 05B

Publications for the Bush Administration which were produced during the period 20 January 1989 to 30 September 1990 for the Executive Office of the President are presented. The actual publications are not presented, but a listing of them and from which particular department. Author

**N91-17820** United States-Japan Task Force on Scientific and Technical Information.
**US-JAPAN TASK FORCE ON SCIENTIFIC AND TECHNICAL INFORMATION**
1990 25 p
(PB90-237561) Copyright Avail: Issuing Activity CSCL 05B

Progress made at the joint meeting of the U.S.-Japan Task Force on Scientific and Technical Information is discussed. The meetings were guided in their agendas by the following objectives: (1) improve the awareness and understanding of organizations and systems established to improve the use of scientific and technical information; (2) increase the quantity and quality of scientific and technical information; (3) reduce impediments, if any, to the flow of scientific and technical information; and (4) increase the translation of scientific and technical information. Y.S.

**N91-17821*#** Rodman and Associates, Inc., Dallas, TX.
**KEYWORD THESAURUS: TERMS AND CODES IDENTIFYING INTEREST AREAS FOR FEDERAL FUNDING OF RESEARCH AND OTHER SPONSORED PROGRAMS, 4TH EDITION, SEPTEMBER, 1990**
Edward M. Walters and John A. Rodman 1990 100 p Sponsored in part by NASA; NSF; National Inst. of Health; DOE; and ONR
(NASA-CR-187752; NAS 1.26:187752; PB90-272279) Avail: NTIS HC/MF A05 CSCL 05B

The Keyword Thesaurus is a classification system for research opportunities emanating from the Federal government and provides a structured method by which agency personnel, faculty members, and research administrators may identify such opportunities. The terms were examined by professional library scientists to ensure consistency with leading discipline dictionaries in each research field of endeavor. Sections include: Program types, coded to funding announcements or solicitations, that indicate the types of activity which may be supported; Target group/Beneficiaries; Keyword-Categorical list; Geographical subdivisions; Keyword-Alphabetical list; and Keyword-Numerical list. Author

**N91-17822#** National Inst. of Standards and Technology, Gaithersburg, MD. Office Systems Engineering Group.
**DYNAMIC CHARACTERISTICS OF HYPERTEXT**
R. Furuta and P. D. Stotts Aug. 1990 14 p Prepared in cooperation with Maryland Univ., College Park Sponsored in part by Northrop Research and Technology Center
(Grant NSF CCR-88-10312)
(PB91-107276; NISTIR-4404) Avail: NTIS HC/MF A03 CSCL 05B

A dynamic hypertext changes even in the absence of user activity. Hypertexts are comprised of structure, content, and context, and dynamic operations may affect any of them. Dynamic operations are synchronous (related to the hypertext's description) or asynchronous. It is argued that such dynamic characteristics are an important component of many hypertext systems, surveying existing implementations to examine the different realizations of dynamic operations, and that dynamic applications are also of importance within the hypertext domain. Author

**N91-17823#** National Inst. of Standards and Technology, Gaithersburg, MD. Information Resources and Services Div.
**DATA BASES AVAILABLE IN THE RESEARCH INFORMATION CENTER OF THE NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY Final Report**
D. Cunningham Sep. 1990 120 p Supersedes PB89-160014
(PB91-107284; NIST/SP-799) Avail: NTIS HC/MF A06; also available SOD HC $6.00 as 003-003-03051-1 CSCL 05B

Data bases available online in the Research Information Center of the National Institute of Standards and Technology (NIST) are listed by acronym and by full title. In addition, descriptions of the data bases, dates covered, producers, hard copy counterpart, principal sources, and vendors are listed. A general subject index and a cross reference index are also supplied. GRA

**N91-17824#** Information-Technology Promotion Agency (Japan).
**INFORMATION-TECHNOLOGY PROMOTION AGENCY, JAPAN: AN INTRODUCTION**
Mar. 1990 10 p
Avail: NTIS HC/MF A02

The Information-Technology Promotion Agency (IPA) was established by Japanese law to promote information processing through high level computer applications, primarily by encouraging development and wider utilization of computer program products and providing aid to companies in the information processing service industry. IPA is engaged in the following activities to promote information processing: (1) Promotion of the development and dissemination of program products; (2) The development of the software industrialized generator and maintenance Aids (SIGMA) system; (3) Credit guarantee; (4) Finance; (5) Research and development of advanced software technologies; (6) Surveys concerning basic software technologies for educational purposes; (7) Surveys on subjects related to information processing, and the dissemination of those results; (8) Evaluation and registration of common use programs; (9) Research and development cooperation; and (10) Support for development of regional software supply capabilities. These activities are described in detail along with the organizational structure of the agency. Author

**N91-17825#** National Inst. of Standards and Technology, Gaithersburg, MD.
**AUTOMATED INFORMATION SYSTEM SECURITY ACCREDITATION GUIDELINES**
Aug. 1990 49 p Sponsored by FAA, Washington, DC
(PB90-264102; NISTIR-4378) Avail: NTIS HC/MF A03 CSCL 05B

This Federal Aviation Administration's publication provides procedures for the preparation of documentation required for security accreditation of automated information systems. It was designed to make the accreditation process as straightforward as possible for any system, whatever its purpose or level of complexity. The accreditation process requires the identification of the data processing activities in the data processing installation and the completion of the forms in this guideline to develop a security

profile of the system, conduct a risk assessment, and document contingency plans. A designated approving authority then signs the accreditation statements that formally accept the risks to each data processing activity. GRA

**N91-17826#** Executive Office of the President, Washington, DC.
**PUBLICATIONS OF THE EXECUTIVE OFFICE OF THE PRESIDENT, JANUARY 20, 1981 - JANUARY 20, 1989**
1990 11 p
(PB90-199563) Avail: NTIS HC/MF A03 CSCL 05B

Publications of the Executive Office of the President during the Reagan Administration are compiled. Reports from Council of Economic Advisers, Council on Environmental Quality, Office of Administration, Office of Management and Budget, Office of Science and Technology Policy, Office of the United States Trade Representative, Office of the Vice President, and White House Office are presented. Y.S.

**N91-17827#** Executive Office of the President, Washington, DC.
**PUBLICATIONS OF THE EXECUTIVE OFFICE OF THE PRESIDENT, JANUARY 20, 1989 - JUNE 30, 1990**
1990 7 p
(PB90-215641) Avail: NTIS HC/MF A02 CSCL 05B

Publications of the Executive Office of the President during the Bush Administration are compiled. The reports from Council of Economic Advisers, Council on Environmental Quality, Office of Administration; Office of Management and Budget, Office of National Drug Control Policy, Office of Science and Technology Policy, Office of the United States Trade Representative, and White House Office are presented. Y.S.

**N91-17828#** Transportation Research Board, Washington, DC.
**GEOGRAPHIC INFORMATION SYSTEMS, 1990**
N. C. Kassabian, A. G. Tobias, L. Caryton, K. Solomon, and N. Solomon 1990 77 p
(PB91-108423; TRB/TRR-1261; ISBN-0-309-05015-4; LC-90-13240; ISSN-0361-1981) Avail: NTIS HC/MF A05 CSCL 05B

The following subject areas are covered: potential for geographic information systems (GIS) in transportation planning and highway infrastructure management; using GIS technology to enhance the pavement management process; pavement management applications of GIS; automated conversion of milepoint data to intersection/link network structure; an application of GIS in transportation; use of GIS in managing hazardous materials shipments; hydrologic GIS; evaluation of GIS workstation performance within a distributed network environment; and emergent roles for optical media in transport engineering. Author

**N91-17829#** National Space Development Agency, Tokyo (Japan).
**[ACTIVITIES OF THE NASDA INSTALLATIONS AND OFFICES]**
1991 47 p
Avail: NTIS HC/MF A03

NASDA is now capable of developing launch vehicles and satellites with indigenous technologies, which are internationally evaluated. Initially, space development began with the modus of launching satellites via launch vehicles, resulting in beneficial applications here on earth. As Japan's initial steps toward manned space activities, beginning in 1991, NASDA will commence performing 34 material processing and life science experiments with a Japanese payload specialist onboard the U.S. Space Shuttle. Space Station Freedom is currently being developed with international efforts. NASDA is responsible for the development and operation of the Japanese Experiment Module (JEM), which will be attached to the Space Station. Japan's participation in the Space Station will contribute to the establishment of manned support technologies and in-orbit assembling techniques for large space structures. In promoting the international collaborative efforts, NASDA seeks resolution to the scientific, medical, and commercial imperatives which make it so important to pursue opportunities in space development. NASDA space development program is thoroughly detailed. Author

**N91-17830#** Michigan Univ., Ann Arbor. Technical Communication Program.
**THE COMPUTERIZED COMPREHENSIBILITY SYSTEM MAINTAINER'S GUIDE Technical Report, 1 Aug. - 12 Sep. 1990**
David E. Kieras 12 Sep. 1990 57 p
(Contract N00014-90-J-4110; NR Proj. RR0-4206)
(AD-A229123; TR-90; ONR-33) Avail: NTIS HC/MF A04 CSCL 12/5

The Computerized Comprehensibility System (CCS) generates a critique of the comprehensibility of a technical document, using techniques and results from artificial intelligence and cognitive psychology. This report is a guide for the maintainer or developer of CCS. It is not intended as a tutorial on the mechanisms used in CCS, but to allow the qualified programmer to rapidly understand the internal mechanisms of CCS in order to correct, modify, or extend the grammar and criticism rules in CCS. This report contains the following sections: an interview of CCS, a description of each of the components of the CCS system, including the syntax for the various representations used in the systems, a series of maintenance examples in which the parser and semantics module of the system are extended to handle new kinds of structures and new criticism rules are added to CCS, and a complete list and explanation of the criticisms produced by the current version. GRA

**N91-17831#** Institute for Defense Analyses, Alexandria, VA.
**A SURVEY OF TOTAL QUALITY MANAGEMENT (TQM) RESOURCE CENTERS Final Report**
James Lester and Sarah H. Nash Mar. 1990 59 p
(Contract MDA903-89-C-0003)
(AD-A229218; AD-E501310; IDA-D-745) Avail: NTIS HC/MF A04 CSCL 05/1

This document describes a study of various models of Total Quality Management Resource Centers that have been established, and is intended to assist in the development of a design for a Department of Defense (DoD) TQM Resource Center. The Institute for Defense Analyses (IDA) surveyed eight organizations with TQM Resource Centers for their designs and operations. While a precise set of organizations models did not emerge from the data collected, three critical design issues did: the level of activity, the degree of centralization, and the philosophy of operation. Moreover, the data from the study did not argue for or against the establishment of a DoD TQM Resource Center, nor was IDA asked to make this determination. Although the organizations surveyed have successfully used TQM Resource Centers to improve quality, at least two organizations who were winners of the prestigious Baldrige Award for Quality did not invest in TQM Resource Centers. Further study is required by the DoD to determine whether a DoD TQM Resource Center is needed and who its customers would be. GRA

**N91-17832#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Systems and Logistics.
**A COMPARISON OF KNOWLEDGE ACQUISITION TECHNIQUES USED IN THE DEVELOPMENT OF EXPERT SYSTEMS M.S. Thesis**
James R. Heatherton Sep. 1990 102 p
(AD-A229252; AFIT/GLM/LSR/90S-23) Avail: NTIS HC/MF A06 CSCL 12/7

The primary objective was to compare three knowledge acquisition techniques used to gather knowledge for the development of an expert system. The goal was to determine which technique produced knowledge in a form most suitable for incorporation into an expert system. The three acquisition techniques compared were interviewing, task observation, and concept mapping. Three experts were selected and randomly paired with a technique. Knowledge acquisition sessions were then conducted with each expert using the technique assigned to that expert. The knowledge extracted from these acquisition sessions was then compared. Overall, concept mapping produced more rules, in less time, and with fewer inferences than the interview or task observation techniques. Additionally, the knowledge base

acquired through the concept mapping technique was more complete. Finally, concept mapping required one less translation of the knowledge to arrive at a form necessary for programming the expert system. An expert system was developed using the concept mapping technique and was validated in a flight test. Results showed that the solutions provided by the expert system matched those provided by the human experts. GRA

**N91-17833*** National Aeronautics and Space Administration, Washington, DC.
**NASA PATENT ABSTRACTS BIBLIOGRAPHY: A CONTINUING BIBLIOGRAPHY. SECTION 1: ABSTRACTS (SUPPLEMENT 38)**
Jan. 1991 64 p
(NASA-SP-7039(38)-SECT-1; NAS 1.21:7039(38)-SECT-1) Avail: NTIS HC A04; NTIS standing order as PB91-911100, $15.00 domestic, $30.00 foreign CSCL 05B

Abstracts are provided for 132 patents and patent applications entered into the NASA scientific and technical information system during the period July 1990 through December 1990. Each entry consists of a citation, an abstract, and in most cases, a key illustration selected from the patent or patent application. Author

**N91-17834*** National Aeronautics and Space Administration, Washington, DC.
**NASA PATENT ABSTRACTS BIBLIOGRAPHY: A CONTINUING BIBLIOGRAPHY. SECTION 2: INDEXES (SUPPLEMENT 38)**
Jan. 1991 537 p
(NASA-SP-7039(38)-SECT-2; NAS 1.21:7039(38)-SECT-2) Avail: NTIS HC A23; NTIS standing order as PB91-911100, $31.00 domestic, $62.00 foreign CSCL 05B

A subject index is provided for over 4900 patents and patent applications for the period May 1969 through December 1990. Additional indexes list personal authors, corporate authors, contract numbers, NASA case numbers, U.S. patent class numbers, U.S. patent numbers, and NASA accession numbers. Author

**N91-17835*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
**NASA/DOD AEROSPACE KNOWLEDGE DIFFUSION RESEARCH PROJECT: REPORT TO PHASE 1 RESPONDENTS Summary Report No. 4**
Thomas E. Pinelli, John M. Kennedy, and Terry F. White (Indiana Univ., Bloomington.) Washington Jan. 1991 9 p
(NASA-TM-102772; NAS 1.15:102772) Avail: NTIS HC/MF A02 CSCL 05B

Phase 1 of a 4 part study was undertaken studying the use of scientific and technical information (STI) by U.S. aerospace engineers and scientists. Specific attention was paid to institutional and socioeconomic variables and to the step-by-step process of information gathering used by the respondents. Data were collected by means of three self administered mail-back questionnaires. The approximately 34,000 members of the American Institute of Aeronautics and Astronautics (AIAA) served as the study population. More than 65 percent of the randomly selected respondents returned the questionnaires in each of the three groups. Respondents relied more heavily upon informal sources of information than formal sources and turned to librarians and other technical information specialists only when they did not obtain results via informal means or their own formal searches. Author

**N91-17984#** European Southern Observatory, Garching (Germany, F.R.). Space Telescope-European Coordinating Facility.
**DEARCHIVING IUE LBL IMAGES FROM OPTICAL DISK**
Fabio Pasian, Michael Barylak, and Piero Benvenuti (European Space Agency, Paris, France ) *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 611-612 (For primary document see N91-17861 09-90)
Copyright Avail: NTIS HC/MF A25; EPD, ESTEC, Noordwijk, Netherlands, HC 80 Dutch guilders

**N91-17985*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
**NSSDC: PRESERVING TIME WITH TECHNOLOGICAL ADVANCES**
Charleen Perry *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 613-615 (For primary document see N91-17861 09-90)
Copyright Avail: NTIS HC/MF A25; EPD, ESTEC, Noordwijk, Netherlands, HC 80 Dutch guilders CSCL 03B

**N91-17986*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
**AN ACCURATE REGISTRATION TECHNIQUE FOR DISTORTED IMAGES**
Michele DeLaPena, Richard A. Shaw, Peter Linde, and Dainis Dravins (Lund Observatory, Sweden ) *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 617-619 (For primary document see N91-17861 09-90)
Copyright Avail: NTIS HC/MF A25; EPD, ESTEC, Noordwijk, Netherlands, HC 80 Dutch guilders CSCL 03B

**N91-17987*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
**A NEW PHOTOMETRIC CORRECTION TECHNIQUE FOR THE IUE FINAL ARCHIVE**
Richard A. Shaw (Computer Sciences Corp., Lanham, MD.) *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 621-622 (For primary document see N91-17861 09-90)
Copyright Avail: NTIS HC/MF A25; EPD, ESTEC, Noordwijk, Netherlands, HC 80 Dutch guilders CSCL 03B

**N91-17988#** Computer Sciences Corp., Lanham, MD. Science Programs.
**THE ARCHIVAL REPROCESSING OF IUE DATA. 3: RESULTS OF THE NEW PROCESSING METHOD FOR IUE DATA**
Joy Y. Nichols-Bohlin, Michele DeLaPena, and Richard A. Shaw *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 623-626 (For primary document see N91-17861 09-90)
Copyright Avail: NTIS HC/MF A25; EPD, ESTEC, Noordwijk, Netherlands, HC 80 Dutch guilders

**N91-17989*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
**A REVISED PARAMETRIZATION OF THE DISPERSION CONSTANTS FOR HIGH DISPERSION IUE IMAGES**
Myron A. Smith (Computer Sciences Corp., Lanham, MD.) *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 627-629 (For primary document see N91-17861 09-90)
Copyright Avail: NTIS HC/MF A25; EPD, ESTEC, Noordwijk, Netherlands, HC 80 Dutch guilders CSCL 03B

**N91-17990*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
**A NEW APPROACH TO REMOVE INTERORDER BACKGROUND IN HIGH DISPERSION IUE IMAGES**
Myron A. Smith (Computer Sciences Corp., Lanham, MD.) *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 631-633 (For primary document see N91-17861 09-90)
Copyright Avail: NTIS HC/MF A25; EPD, ESTEC, Noordwijk, Netherlands, HC 80 Dutch guilders CSCL 03B

# 83 ECONOMICS AND COST ANALYSIS

Includes cost effectiveness studies.

**N91-17836*#** National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
**PROJECT LASER: LEARNING ABOUT SCIENCE, ENGINEERING, AND RESEARCH**
Jan. 1990 13 p Original contains color illustrations
(NASA-TM-103382; NAS 1.15:103382) Avail: NTIS HC/MF A03; 5 functional color pages CSCL 05I

The number of American students entering science and engineering careers and their ranking in comparison with other countries is on the decline. This decline has alarmed Congress which, in 1987, established a Task Force on Women, Minorities, and the Handicapped in Science and Technology to define the problem and find solutions. If left unchanged, the task force has warned that the prospects for maintaining an advanced industrial society will diminish. NASA is supportive of the six goals outlined by the task force, which are paraphrase herein, and is carefully assessing its education programs to identify those offering the greatest potential for achieving the task force objectives with a reasonable range of resources. A major initiative is under way on behalf of NASA at its Marshall Space Flight Center, where highly effective features of several NASA education programs along with innovations are being integrated into a comprehensive pilot program. This program, dubbed Project LASER, is discussed. Author

**N91-17052*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
**SYSTEMS ENGINEERING AND INTEGRATION: COST ESTIMATION AND BENEFITS ANALYSIS**
Ed Dean, Ernie Fridge, and Joe Hamaker (National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.) *In* NASA, Washington, Space Transportation Avionics Technology Symposium. Volume 2: Conference Proceedings Aug. 1990 p 695-699 (For primary document see N91-17020 09-06)
Avail: NTIS HC/MF A99 CSCL 05C

# 84 LAW, POLITICAL SCIENCE AND SPACE POLICY

Includes NASA appropriation hearings; aviation law; space law and policy; international law; international cooperation; and patent policy.

No abstracts in this category.

# 85 URBAN TECHNOLOGY AND TRANSPORTATION

Includes applications of space technology to urban problems; technology transfer; technology assessment; and surface and mass transportation.

For related information see also *03 Air Transportation and Safety, 16 Space Transportation,* and *44 Energy Production and Conversion.*

**N91-17837#** National Science Foundation, Washington, DC. Div. of Science Resources Studies.
**SCIENTIFIC AND ENGINEERING RESEARCH FACILITIES AT UNIVERSITIES AND COLLEGES, 1990**
Kenneth Burgdorf, Paul Newman, Terrie Squadere, William Renfew, and Judith F. Coakley Sep. 1990 138 p Prepared in cooperation with Westat Research, Inc., Rockville, MD
(PB90-272006; NSF-90-318) Avail: NTIS HC/MF A07 CSCL 05I

The report to Congress based on National Science Foundation's 1990 Survey of Scientific and Engineering Research Facilities at Universities and Colleges is discussed. The survey data on new and deferred constitution, new and deferred repair/renovation, and the condition and adequacy of existing research facilities are based on both quantitative and qualitative assessments provided by academic research institutions. Y.S.

# 88 SPACE SCIENCES (GENERAL)

**N91-17884#** Tokyo Univ. (Japan). Inst. of Space and Astronautical Science.
**SPACE RESEARCH PROGRAMME OF JAPAN**
Y. Tanaka *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 183-187 (For primary document see N91-17861 09-90)
Copyright Avail: NTIS HC/MF A25; EPD, ESTEC, Noordwijk, Netherlands, HC 80 Dutch guilders

# 89 ASTRONOMY

Includes radio, gamma-ray, and infrared astronomy, and astrometry.

**N91-17838#** Naval Observatory, Washington, DC.
**ASTRONOMICAL PHENOMENA FOR THE YEAR 1991**
1990 78 p Prepared in cooperation with Royal Greenwich Observatory, Cambridge, England
(ISBN-0-11-886933-7) Avail: NTIS HC/MF A05

Astronomical phenomena for the year 1991 are presented in tabular form. Data is given on seasons, Moon phases, eclipses, occultations, perigee and apogee of the Moon, geocentric and heliocentric planetary phenomena, times of meridian passages of planets, sunrise and sunset times, moonrise and moonset times, international times zones and other phenomena. Author

**N91-17839*#** National Aeronautics and Space Administration, Washington, DC.
**EXPLORING THE UNIVERSE WITH THE HUBBLE SPACE TELESCOPE**
1990 69 p Original contains color illustrations
(NASA-NP-126; NAS 1.83:126) Avail: NTIS HC/MF A04; also available SOD HC $6.50 as 033-000-01066-4; 57 functional color pages CSCL 03A

A general overview is given of the operations, engineering challenges, and components of the Hubble Space Telescope. Deployment, checkout and servicing in space are discussed. The optical telescope assembly, focal plane scientific instruments, wide field/planetary camera, faint object spectrograph, faint object camera, Goddard high resolution spectrograph, high speed photometer, fine guidance sensors, second generation technology, and support systems and services are reviewed. Author

**N91-17840*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
**HUBBLE SPACE TELESCOPE: A COSMIC TIME MACHINE**
J. A. Westphal, R. J. Harms, J. C. Brandt, R. C. Bless, F. D. Macchetto, and W. H. Jefferys (Texas Univ., Austin.) 1991 18 p Prepared in cooperation with Jet Propulsion Lab., California Inst. of Tech.; Martin Marietta Aerospace; Ball Bros. Research; Dornier Systems, GmbH; MATRA Espace; and British Aerospace Aircraft Group Original contains color illustrations
(NASA-TM-103041; NAS 1.15:103041) Avail: NTIS HC/MF A03; 16 functional color pages CSCL 03A

The mission of the Hubble Space Telescope (HST) is to explore the expanding and evolving universe. During the 3,000 operating hours every year for the next 15 years or more, the HST will be used to study: galaxies; pulsars; globular clusters; neighboring stars

where planets may be forming; binary star systems; condensing gas clouds and their chemical composition; and the rings of Saturn and the swirling ultraviolet clouds of Venus. The major technical achievements - its nearly perfect mirrors, its precise guidance system of rate gyroscopes, reaction wheels, star trackers, and fine guidance sensors are briefly discussed. The scientific instruments on board HST are briefly described. The integration of the equipment and instruments is outlined. The Space Telescope Science Institute (STScI) has approved time for 162 observations from among 556 proposals. The mission operation and data flow are explained. B.G.

**N91-17841** Pennsylvania State Univ., University Park.
**APPLICATION OF THE HEAO-1 A-2 LOW ENERGY DETECTOR DATA TO THE DIFFUSE X RAY SKY BACKGROUND Ph.D. Thesis**
Richard Lee Fink 1990 305 p
Avail: Univ. Microfilms Order No. DA9032273

The diffuse x ray sky background over the energy range 0.2 to 3 keV is examined using data from the HEAO-1 A-2 Low Energy Detectors (LED). A value for the extragalactic power law normalization of 10.4 + or - 0.5 is obtained. The galactic spectral components of the power law residual are found to be well explained at the North and South Ecliptic Poles by a standard unabsorbed/absorbed two temperature thermal plasma model. A published galactic halo model is tested and found not to provide acceptable results based on LED galactic latitude data and the spatial location of the model 1/4 keV energy band emission. Dissert. Abstr.

**N91-17842** Minnesota Univ., Minneapolis.
**INFRARED POLARIZATION STUDIES OF BOK GLOBULES Ph.D. Thesis**
Dimitri Ivanovich Klebe 1990 106 p
Avail: Univ. Microfilms Order No. DA9033194

Near-infrared photometry and polarimetry and optical polarimetry of field stars shining through the Bok globules B118, B133, and B361 are presented. Three distinct density distributions are found and mass estimates of the inner regions of these globules are given. Near-infrared polarimetry was done using the Minnesota Infrared Polarimeter whose construction, operation, and signal to noise performance are also discussed. The polarization vectors show no indication that the magnetic field in the globules is being compressed due to gravitational collapse. The general direction of the polarization vectors is parallel to the plain of the Galaxy in all three globules. The presence of aligned grains in the isolated and cold environments of these globules demands an efficient grain alignment mechanism. A model describing the polarizing properties of the interstellar medium is presented. The model is based on the premise that the mechanism responsible for grain alignment is sufficient to provide 100 percent alignment of all polarizing grains with their local magnetic fields independent of field strength. The model predicts an equipartition of the magnetic and turbulent or kinetic energy densities in order to fit the available polarization data for the Galaxy. The model requires that along any given line of sight, that the interstellar medium be composed of segments in which a random component of the magnetic field direction is uncorrelated with the field direction in the preceding or following segment. The model requires that the optical depth of an individual segment be 0.1 at K to best represent conditions in the interstellar medium, particularly for optical depths less than unity. Dissert. Abstr.

**N91-17843** California Inst. of Tech., Pasadena.
**A SEARCH FOR ANISOTROPY IN THE COSMIC MICROWAVE BACKGROUND ON ANGULAR SCALES OF 1 TO 30 ARCMINUTES Ph.D. Thesis**
Steven Theodore Myers 1990 223 p
Avail: Univ. Microfilms Order No. DA9031475

Observations at a frequency of 20 GHz from the Owens Valley Radio Observatory with the 40 meter diameter radiotelescope are used to place limits on the anisotropy of the cosmic microwave background radiation, believed to be a relic from the Big Bang. Two experiments, designated NCP and RING, were performed with the former consisting of deep measurements in 8 fields at the declination delta = 89 degrees and the later a survey of 96 fields at declination delta = 88 deg 10 min 42 sec. Bayesian statistical analysis of the 8 NCP field observations place a 95 percent confidence upper limit of delta T/T is less than 1.9 x 10(exp -5) and 4.2 x 10(exp -5) for 99.87 percent confidence (3 sigma) on the amplitude of fluctuations. The 96 fields of the RING experiment were observed in an interlocked ring-like geometry to enhance the sensitivity of the experiment to larger-scale anisotropies. Because of the larger area of sky covered, this data was more susceptible to contamination by discrete extragalactic radio sources and separate lower frequency observations were used to identify and correct for the contribution of these objects. The statistical analysis of the RING data results in the limits on the anisotropy of 2.5 is less than delta T/T is less than 5.0 x 10(exp -5) (95 percent) and 1.9 is less than delta T/T is less than 6.1 x 10(exp -5) (99.87 percent) for fluctuations with a correlation angle of 2.6 min. Because of the high probability of residual source contamination, these results are treated as upper limits on intrinsic background fluctuations. These experiments constrain the amplitude to be less than 3 x 10(exp -4) for correlation angles between 0.1 and 30 min (95 percent). The implications for cosmology and theories of galaxy formation are discussed, and models without significant non-baryonic matter and/or non-standard recombination are excluded by the observations. Dissert. Abstr.

**N91-17844#** National Inst. of Standards and Technology, Gaithersburg, MD. Radiometric Physics Div.
**ABSOLUTE SPECULAR REFLECTOMETER WITH AN AUTOCOLLIMATOR TELESCOPE AND AUXILIARY MIRRORS Final Report**
T. M. Wang, K. L. Eckerle, and J. J. Hsia Aug. 1990 32 p
(PB90-269572; NIST/TN-1280) Avail: NTIS HC/MF A03; also available SOD HC $2.00 as 003-003-03043-5 CSCL 03A

The Strong method for measuring reflectance is used in many laboratories. However, uncertainty in the angular position of the sample can lead to large errors. A novel use of an autocollimator telescope with two auxiliary mirrors (ACTAM) can reduce this angular uncertainty and lead to more accurate measurement of reflectance. The instrumentation, its adjustment, measurement procedure, results, and uncertainties are discussed. The total uncertainty for the reflectance measurement of a gold mirror was found to be less than 0.0025 over the wavelength region 2 to 22 microns. Author

**N91-17845*#** Alabama Univ., Huntsville. Dept. of Computer Science.
**HUBBLE SPACE TELESCOPE DESIGN ENGINEERING KNOWLEDGEBASE (HSTDEK) Final Technical Report, 12 Sep. 1988 - 11 Sep. 1989**
James D. Johannes and Clark Everetts 1989 7 p
(Grant NAG8-117)
(NASA-CR-187838; NAS 1.26:187838; UAH-5-31976) Avail: NTIS HC/MF A02 CSCL 03A

The research covered here pays specific attention to the development of tools to assist knowledge engineers in acquiring knowledge and to assist other technical, engineering, and management personnel in automatically performing knowledge capture as part of their everyday work without adding any extra work to what they already do. Requirements for data products, the knowledge base, and methods for mapping knowledge in the documents onto the knowledge representations are discussed, as are some of the difficulties of capturing in the knowledge base the structure of the design process itself, along with a model of the system designed. The capture of knowledge describing the interactions of different components is also discussed briefly. Author

**N91-17846*#** California Univ., Berkeley. Space Sciences Lab.
**FAR INFRARED ALL-SKY SURVEY Final Technical Report, 1 Feb. 1976 - 30 Apr. 1990**
Paul L. Richards 1991 9 p

(Grant NsG-7205)
(NASA-CR-186437; NAS 1.26:186437) Avail: NTIS HC/MF A02 CSCL 03A

An all-sky survey at submillimeter waves is examined. Far-infrared all-sky surveys were performed using high-thoroughput bolometric detectors from a one-meter balloon telescope. Based on the large-bodied experience obtained with the original all-sky survey telescope, a number of radically different approaches were implemented. Continued balloon measurements of the spectrum of the cosmic microwave background were performed. Y.S.

**N91-17847** Max-Planck-Inst. fuer Physik und Astrophysik, Garching (Germany, F.R.). Inst. fuer Extraterrestrische Physik.
**THE FAR-INFRARED AND SUBMILLIMETRE SPACE TELESCOPE (FIRST)**
R. Genzel and U. Frisk (European Space Agency. European Space Research and Technology Center, ESTEC, Noordwijk, Netherlands) Sep. 1990 8 p Presented at 28th COSPAR Meeting (Meeting No. 28 in the Infrared and Submillimeter Universe at High Redshifts), The Hague, Netherlands, 25-27 Jun. 1990 Submitted for publication
(MPE-PREPRINT-191; ETN-91-98615) Copyright Avail: Fachinformationszentrum Karlsruhe, 7514 Leopoldshafen-Eggenstein 2, Fed. Republic of Germany

The far infrared and submillimeter Space Telescope (FIRST) is planned by the European Space Agency (ESA) as one of its four Horizon 2000 cornerstones. FIRST opens the virtually unexplored waveband of the electromagnetic spectrum between just below 100 microns and 1 mm for detailed astrophysical measurements and can be used for detailed spectroscopy of the cold and warm components of the universe out to cosmological distances. The scientific impact, the spacecraft, telescope, orbit, thermal control, payload and status of FIRST are discussed. ESA

**N91-17848#** Los Alamos National Lab., NM.
**JASA: A PROTOTYPE WATER-CERENKOV AIR-SHOWER DETECTOR**
D. Berley, C. Dion, J. A. Goodman, T. J. Haines, P. W. Kwok, M. J. Stark, R. C. Svoboda (Louisiana State Univ., Baton Rouge.), H. Ferguson, C. M. Hoffman, and E. Horch et al 1990 7 p Presented at the International Conference on High Energy Gamma Ray Astronomy, Ann Arbor, MI, 2-5 Oct. 1990 Sponsored in part by NSF
(Contract W-7405-eng-36)
(DE91-005870; LA-UR-90-4436; CONF-9010289-1) Avail: NTIS HC/MF A02

A small pilot experiment to examine the use of the water-Cerenkov technique for air shower detection was installed near the center of the CYGNUS air shower array. Preliminary results showing general agreement with simulations are presented. Thus, the technique promises to offer significant advances for VHE-UHE (gamma)-ray astronomy. DOE

**N91-17849#** Los Alamos National Lab., NM.
**THE SHOWERFRONT TIME-STRUCTURE OF ANOMALOUS MUON EVENTS ASSOCIATED WITH HERCULES X-1**
D. E. Alexandreas, R. C. Allen, S. D. Biller, G. M. Dion, X-Q. Lu, P. R. Vishwanath, G. B. Yodh, D. Berley, C. Y. Chang, and B. L. Dingus (Maryland Univ., College Park.) et al 1990 6 p Presented at the International Conference on High Energy Gamma Ray Astronomy, Ann Arbor, MI, 2-5 Oct. 1990
(Contract W-7405-eng-36)
(DE91-005890; LA-UR-90-4433; CONF-9010289-2) Avail: NTIS HC/MF A02

The 11 in-phase source events from the 1986 muon-rich bursts associated with Hercules X-1 (previously reported by this group) have been studied for indications of further anomalous behavior. The most significant effect observed resulted from an analysis of the showerfront time-structures of these events. This analysis was then applied a priori to the rest of the source day, where an additional approximately 9 signal events are expected to remain. The same effect was observed at a chance probability level of approximately 0.1 percent. DOE

# 90 ASTROPHYSICS

Includes cosmology; celestial mechanics; space plasmas; and interstellar and interplanetary gases and dust.
For related information see also *75 Plasma Physics*.

**N91-17850** Oxford Univ. (England).
**ORBITAL MOTION IN STELLAR SYSTEMS Ph.D. Thesis**
P. N. Binks 1988 154 p
Avail: Univ. Microfilms Order No. BRD-85838

Researchers investigated the possibility of developing an angle action representation of the motion of stars in potentials that approximate to those of elliptical galaxies. The method is based on the observation that the Fourier amplitudes of the spectral decomposition of coordinate motion decreases asymptotically for a variety of orbits in integral and near-integral two dimensional potential. Analytic results for motion in a one dimensional Kepler potential support this conclusion. The researchers therefore choose to approximate the series of Fourier amplitudes by a geometric sum. They found that the rational approximation to Fourier series is a considerable improvement upon present techniques for eccentric orbits. The orbit representation is then fitted to the orbit's phase-space torus via an iterative scheme similar to that of Ratcliff, Chang and Swarzschild (1984). The major work here concerns the construction and modification of this scheme to enable convergence of the initial representation to an accurate orbital solution. The results indicate that the representation is indeed capable of accurately depicting short-axis tube orbits in integrable and near-integrable potentials. Dissert. Abstr.

**N91-17851** Texas Univ., Austin.
**MACH'S PRINCIPLE AND ROTATING UNIVERSES Ph.D. Thesis**
David Henry King 1990 146 p
Avail: Univ. Microfilms Order No. DA9031620

It is shown that the Bianchi 9 model universe satisfies the Mach principle. These closed rotating universes were previously thought to be counter-examples to the principle. The Mach principle is satisfied because the angular momentum of the rotating matter is compensated by the effective angular momentum of gravitational waves. A new formulation of the Mach principle is given that is based on the field theory interpretation of general relativity. Every closed universe with 3-sphere topology is shown to satisfy this formulation of the Mach principle. It is shown that the total angular momentum of the matter and gravitational waves in a closed 3-sphere topology universe is zero. Dissert. Abstr.

**N91-17852** Texas Univ., Austin.
**GLOBAL STAR FORMATION IN THE L1630 MOLECULAR CLOUD Ph.D. Thesis**
Elizabeth Anne Lada 1990 124 p
Avail: Univ. Microfilms Order No. DA9031628

The results of a study of dense cores and star formation in the L1630 (Orion B) molecular cloud are presented. Unbiased, well sampled, systematic surveys for density condensations and embedded infrared sources in the L1630 cloud were completed in an attempt to understand the relationship between dense cores and young stars. To identify the dense cores, L1630 was surveyed in the J=2-1 transition of CS using a 7-m telescope. Thirteen thousand positions were surveyed with 1 degree spacing to an rms noise level of 0.2 K. The total area covered was approximately 3.6 square degrees. Emission was detected over 10 percent of the area surveyed and this emission is not uniformly distributed throughout the cloud but is confined in 42 dense cores. A 2.2 micron survey of a significant portion of the L1630 cloud was carried out using an infrared array camera on a 1.3-m telescope. Three thousand 1 degree x 1 degree fields were surveyed, covering an area of approximately 0.8 square degrees. These regions included both areas containing CS emission and areas without CS emission. The completeness limit of this survey is estimated to be 13th magnitude at K (approximately 0.16 solar mass main sequence dwarf). As a result, four embedded infrared clusters were identified. These embedded clusters contain at least 58 percent but possibly as much as 96 percent of the total number

of sources associated with this molecular cloud suggesting that the dominant mode of star formation in this region is in clusters. The CS and 2.2 micron surveys of L1630 provided the first census of dense cores and young stellar objects within a molecular cloud. A comparison of these surveys clearly shows that star formation in the region surveyed occurs exclusively in the dense gas. It is shown that the star formation in L1630 is a highly localized process both within the molecular cloud and within the dense gas.
Dissert. Abstr.

**N91-17853** California Inst. of Tech., Pasadena.
**STAR FORMATION AND THE INTERSTELLAR MEDIUM IN M33 Ph.D. Thesis**
Christine Diana Wilson 1990 251 p
Avail: Univ. Microfilms Order No. DA9031497

New high-resolution millimeter-wave and optical data are used to study high-mass star formation and its relationship with the interstellar medium in the inner 4' radius of the nearby spiral galaxy M33. The masses, diameters, and velocity widths of molecular clouds in M33 are very similar to those of Galactic clouds. The mass distribution of clouds in M33 is consistent with the Galactic distribution for M = 0.8 to 4 x 10(exp 5) solar mass but contains no clouds with masses greater than 4 x 10(exp 5) solar mass. A model is proposed to explain the high-mass cutoff to the mass distribution as arising from the competing processes of cloud growth through accretion and destruction through star formation. Fifty percent of the molecular gas in M33 resides in structures less massive than 0.8 x 10(exp 5) solar mass in contrast to the Galaxy where only 15 percent of the molecular gas mass is in these smaller structures. The spatial distributions of the H alpha, CO, and H I emission peaks suggest that atomic gas peaks are formed via photodissociation of molecular gas by recent high-mass star formation. The blue luminosity function for field stars in M33 is deficient at bright magnitudes relative to the luminosity function for stars in associations. In addition, associations in the northern arm contain no stars more massive than 20 solar mass while associations in the southern arm contain stars up to 60 solar mass. These differences may be due to a sudden cessation of star formation or to a smaller upper mass cutoff to the initial mass function in the field and the northern arm. Star formation rates obtained from H alpha luminosity, far-infrared luminosity, and number counts of blue stars agree to within a factor of two. The vigorous star formation in the spiral arms of M33 is due to the presence of large amounts of molecular gas and not to an increased star formation efficiency. Dissert. Abstr.

**N91-17854** Texas Univ., Austin.
**ASTERO-ARCHAEOLOGY: READING THE GALACTIC HISTORY RECORDED IN THE WHITE DWARF STARS Ph.D. Thesis**
Matthew Alan Wood 1990 277 p
Avail: Univ. Microfilms Order No. DA9031753

Galactic history is written in its oldest stars, the white dwarfs. Although still some years away from reading the details of that history, significant limits can already be placed on both the Galactic age and star formation history. The following is a complete analysis of the problem, starting with a fresh exploration of the physics of white dwarf stars. An extensive grid of numerical model sequences is presented and these are used to describe in detail the behavior of the white dwarf stars as a function of mass, core composition, surface layer masses and compositions, and uncertainties in the constitutive physics. These model sequences are used to decode the information contained in the white dwarf luminosity function. A theoretical context is established for current and future observations by presenting luminosity functions computed with differing choices for the input white dwarf evolutionary sequences, the assumed age of the local disk, the star formation rate as a function of time, and the possibility of scale height inflation of the disk with time. Finally, white dwarf cosmochronology is discussed within the context of other, conflicting, methods of cosmochronology. How this work can help resolve these conflicts and shed light on fundamental problems in galaxy formation and cosmology.
Dissert. Abstr.

**N91-17855#** Research Inst. of National Defence, Linkoeping (Sweden). Huvudavdelning foer Informationsteknologi.
**INVESTIGATION OF THE TIME-SPREAD IN OVERDENSE METEOR TRAILS**
G. Eriksson Mar. 1990 29 p
(PB90-267022; FOA-C-30570-8.3) Avail: NTIS HC/MF A03 CSCL 03B

High resolution measurements were carried out to characterize the time spread properties of the overdense meteor trails. A number of other parameters of interest for adaptive communication systems were examined for both underdense and overdense trails. The measurement system is described and the results are presented. It was found that the time spread in the overdense trails is not severe for data rates up to 250 to 500 kbits/s. For the underdense trails, the exponential decay constant shows great variations, and a great part of the trails have significant rise time. Author

**N91-17856#** Florida Univ., Gainesville. Inst. for Fundamental Theory.
**ANGULAR MOMENTUM OF AN ELECTRIC CHARGE AND MAGNETICALLY CHARGED BLACK HOLE**
D. Garfinkle (California Univ., Santa Barbara.) and Soo-Jong Rey 1990 10 p
(Contract DE-FG05-86ER-40272)
(DE91-005040; DOE/ER-40272/114; UFIFT-HEP-90-27) Avail: NTIS HC/MF A02

We find the angular momentum L of a point particle with electric charge e held at a fixed position in the presence of a black hole with magnetic charge g. (For a point charge in the presence of an ordinary magnetic monopole, it is known that L = eg). The angular momentum does depend on the separation distance between the particle and the black hole; however, L (yields) eg for a large separation. Implications for the cosmic censorship hypothesis, the quantum hairs and other physical situations are discussed. DOE

**N91-17857#** Lawrence Livermore National Lab., CA.
**THE ORIGIN AND DEVELOPMENT OF INSTABILITIES IN RADIATIVELY-DRIVEN STELLAR WINDS**
John I. Castor 20 Nov. 1990 15 p Presented at the NATO Advanced Workshop on Stellar Atmospheres: Beyond Classical Models, Trieste, Italy, 3-7 Sep. 1990
(Contract W-7405-eng-48)
(DE91-005430; UCRL-JC-105534; CONF-9009308-4) Avail: NTIS HC/MF A03

The numerous observational indicators of instability in the radiatively-driven winds of hot stars are reviewed, followed by a summary of the present theoretical understanding of the linear instability of such winds. This provides the motivation for the hydrodynamic simulation, the major thrust of the paper. A serious approximation that must be made in order to reduce the cost of the simulations to a reasonable level--the absorption approximation for the radiation force--is discussed in some detail. The hydrodynamic methods are described briefly, and then the computational results for winds models computed in the absorption approximation are discussed. The most notable results pertain to the critical nature of the ratio v(sub th)/a of the intrinsic line width to the sound speed. When this ratio is large, only a negligible wind results; when the ratio is small, the wind executes permanent self-excited oscillations; in an intermediate range the wind is globally stable, but acts as a powerful wave amplifier. The morphology of the oscillations--strong rarefactions and reverse shocks--is described and related to Abbott's linear theory, and the possible connection to observations is mentioned. DOE

**N91-17858#** Los Alamos National Lab., NM. Theoretical Div.
**THE ENTROPY IN SUPERNOVA EXPLOSIONS**
Stirling A. Colgate Dec. 1990 10 p Presented at the ESO/EIPC Workshop: SN1987A and Other Supernova, Isola d'Elba, Italy, 17-22 Sep. 1990
(Contract W-7405-eng-36)
(DE91-005876; LA-UR-90-4264; CONF-9009320-1) Avail: NTIS HC/MF A02

The explosion of a supernova forms because of the collapse to a neutron star. In addition an explosion requires that a region of relatively high entropy be in contact with the neutron star and persisting for a relatively protracted period of time. The high entropy region ensures that the maximum temperature in contact with the neutron star and in hydrostatic equilibrium is less than some maximum. This temperature must be low enough such that neutrino emission cooling is small, otherwise the equilibrium atmosphere will collapse adding a large accretion mass to the neutron star. A so-called normal explosion shock that must reverse the accretion flow corresponding to a typical stellar collapse must have sufficient strength or pressure to reverse this flow and eject the matter with 10(exp 51) ergs for a typical type II supernova. Surprisingly, the matter behind such a shock wave has a relatively low entropy low enough such that neutrino cooling would be orders of magnitude faster than the expansion rate. The resulting accretion low would be inside the Bondi radius and result in free-fall accretion inside the expanding rarefaction wave. The accreted mass or reimplosion mass unless stopped by a high entropy bubble could then exceed that of bound neutron star models. In addition, the explosion shock would be overtaken by the rarefaction wave and either disappear or at least weaken. Hence, a hot, high entropy bubble is required to support an equilibrium atmosphere in contact with a relatively cold neutron star. Subsequently, during the expansion of the high entropy bubble that drives or pushes on the shocked matter, mixing of the matter of the high entropy bubble and lower entropy shock-ejected matter is ensured. The mixing is driven by the negative entropy gradient between the high entropy bubble accelerating the shocked matter and the lower entropy of the matter behind the shock. DOE

**N91-17859#** State Univ. of New York, Stony Brook. Dept. of Earth and Space Sciences.

**RESEARCH IN NUCLEAR ASTROPHYSICS: STELLAR COLLAPSE AND SUPERNOVAE Technical Progress Report, 1 Dec. 1989 - 30 Nov. 1990**

J. M. Lattimer and A. Yahil 1990 23 p

(Contract DE-FG02-87ER-40317)

(DE91-005988; DOE/ER-40317/3) Avail: NTIS HC/MF A03

The interaction between nuclear theory and some outstanding problems in astrophysics has been examined. We have been actively researching, on one hand, the astrophysics of gravitational collapse, neutron star birth, and the emission of neutrinos from supernovae and, on the other hand, the nuclear physics of the equation of state of hot, dense matter. There is close coupling between nuclear theory and supernova and neutron star phenomenon; in fact, nuclear matter properties, especially supernuclear densities, might be best delineated by astrophysical considerations. Our research has also focused on the neutrinos emitted from supernovae, since they are the only available observables of the internal supernova mechanism. The recent observations of neutrinos from SN 1987A proved to be in remarkable agreement with models we pioneered prior to its explosion. We have also developed a hydrodynamical code in which shocks are treated via Riemann resolution rather than with artificial viscosity. We have also extended models of the neutrino emission and cooling of neutron stars to include the effects of rotation. The Lattimer compressible liquid drop model is the basis of our equation of state. We have developed a rapid version for use in hydrodynamic codes that retains essentially all the physics of earlier, more detailed equations of state. We have also focused on the nuclei-nuclear matter phase transition just below nuclear matter density, including the probable nuclear deformations and the possible inside-out phase of bubbles, which could be of major importance in supernovae models. Work also progressed toward understanding the origin of the r-process elements, through focusing on the neutron star decompression model. DOE

**N91-17860*#** Fermi National Accelerator Lab., Batavia, IL. Astrophysics Center.

**EXPERIMENTALLY TESTING THE STANDARD COSMOLOGICAL MODEL**

D. N. Schramm Nov. 1990 23 p Presented at the 25th IUPAP International Conference on High Energy Physics, Singapore, 2-8 Aug. 1990 Prepared in cooperation with Chicago Univ., IL

(Contract NAGw-1321; NAGw-1340; DE-AC02-76CH-03000; NSF AST-88-22595)

(NASA-CR-187970; NAS 1.26:187970; DE91-006384; FERMILAB-CONF-90/241-A; CONF-900822-24) Avail: NTIS HC/MF A03 CSCL 03B

The standard model of cosmology, the big bang, is now being tested and confirmed to remarkable accuracy. Recent high precision measurements relate to the microwave background; and big bang nucleosynthesis, which is studied since it relates more directly to high energy experiments. In particular, the recent LEP (and SLC) results on the number of neutrinos are discussed as a positive laboratory test of the standard cosmology scenario. Discussion is presented on the improved light element observational data as well as the improved neutron lifetime data. Alternate nucleosynthesis scenarios of decaying matter or of quark-hadron induced inhomogeneities are discussed. It is shown that when these scenarios are made to fit the observed abundances accurately, the resulting conclusions on the baryonic density relative to the critical density, Omega sub b, remain approximately the same as in the standard homogeneous case, thus, adding to the robustness of the standard model conclusion that Omega sub b approx. 0.06. This latter point is the deriving force behind the need for non-baryonic dark matter (assuming Omega sub total = 1) and the need for dark baryonic matter, since Omega sub visible less than Omega sub b. Recent accelerator constraints on non-baryonic matter are discussed, showing that any massive cold dark matter candidate must now have a mass M sub x approx. greater than 20 GeV and an interaction weaker than the Z sup 0 coupling to a neutrino. It is also noted that recent hints regarding the solar neutrino experiments coupled with the see-saw model for micromasses may imply that the nu sub tau is a good hot dark matter candidate. DOE

**N91-17861#** European Space Agency, Paris (France).

**EVOLUTION IN ASTROPHYSICS: IUE ASTRONOMY IN THE ERA OF NEW SPACE MISSIONS**

Erica J. Rolfe, ed. Aug. 1990 597 p International conference held in Toulouse, France, 29 May - 1 Jun. 1990; sponsored by NASA, ESA, Science and Engineering Research Council, CNES, and Toulouse Univ.

(ESA-SP-310; ISBN-92-9092-082-3; ISSN-0379-6566; ETN-91-98622) Copyright Avail: NTIS HC/MF A25; EPD, ESTEC, Noordwijk, Netherlands, HC 80 Dutch guilders

Various aspects of ultraviolet astronomy are discussed with particular emphasis being given to the role played by data from the International Ultraviolet Explorer (IUE). Chemical composition of various stars and stellar objects are studied. Normal stars and the solar system are reported on. Clusters, binary systems, and compact objects are studied. Interstellar medium, active galaxies, and space astronomy are discussed. Normal galaxies, image processing, the IUE archives, and archiving techniques are outlined. For individual titles, see N91-17862 through N91-17990.

**N91-17862#** Observatoire de Midi-Pyresnees, Toulouse (France).

**COMPARATIVE STUDY OF COMETOLOGY FROM IUE OBSERVATIONS**

M. C. Festou *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 3-10 (For primary document see N91-17861 09-90)

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Since 1978 the International Ultraviolet Explorer (IUE) spacecraft has allowed the ultraviolet spectrum of about 40 comets to be studied, many during extensive periods of time. Objects that have very different orbital histories were observed. These observations allow the composition of the coma and the overall gaseous output of the nucleus as well as its variation with heliocentric distance to be determined. Extensive comparative studies of the properties of the observed comets are shown to be

possible. Dissimilarities are far less common than similarities. Future possibilities of being able to distinguish between primordial differences and aging evolution processes are discussed. ESA

**N91-17863#** Observatoire de Paris-Meudon (France). Dept. de Recherche Spatiale.
**PRE-MAIN SEQUENCE STARS**
C. Catala and C. Bertout (Institut d'Astrophysique, Paris, France ) *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 11-22 (For primary document see N91-17861 09-90)
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High and low resolution IUE (International Ultraviolet Explorer) spectra of low mass (T Tauri stars) and more massive (Herbig Ae/Be stars) young stars are discussed. Information about their atmospheric layers and their close environment is analyzed. IUE observations show that strong nonradiative heating occurs in the atmospheres of these young stars. The relevant observational material is reviewed and the questions of the origin of this nonradiative energy flux is discussed. The flux originates from the stellar interior in the form of magnetic activity in weak emission line T Tauri stars. In the more exotic classical T Tauri stars, it is more likely to be caused mainly by the interaction of the young star with a circumstellar disk. In the Herbig Ae/Be stars, the origin of nonradiative energy is not settled. Clues for both magnetic activity and disk activity in these objects are discussed. ESA

**N91-17864*#** Washington Univ., Seattle. Dept. of Astronomy.
**HERBIG-HARO OBJECTS**
K. H. Boehm *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 23-31 (For primary document see N91-17861 09-90)
(Grants NAG5-45; NSF AST-89-18458)
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The IUE (International Ultraviolet Explorer) spectra of Herbig-Haro (HH) objects and their relation to the very detailed optical spectra available for these objects are studied. Useful information about the physics of HH objects in general and especially about their hydrodynamic models which are contained in these IUE observations is outlined. The merged spectra of high excitation, low excitation HH objects (like HH43 and HH47), and peculiar HH objects are discussed. Results of the spatial variation of lines and continua in HH objects are discussed. Their compatibility with predictions for aerodynamic and especially bow shock models is discussed. The problems arising in the interpretation of the continuous energy distribution in the short wavelength range are discussed. They require the presence of other emission mechanisms in addition to the collisionally enhanced two photon continuum. In HH43 the fluorescent H2 line emission comes from a surprisingly small spatial region. Implications of these results are discussed. ESA

**N91-17865#** Landessternwarte auf dem Koenigstuhl, Heidelberg (Germany, F.R.).
**LUMINOUS HOT VARIABLES**
B. Wolf *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 33-37 (For primary document see N91-17861 09-90)
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The main characteristics of Luminous Hot Variables (LBVs) are reviewed. The long lived IUE (International Ultraviolet Explorer) has played a crucial role in getting a better physical understanding of outburst processes of LBVs due to long term monitoring programs. Special emphasis is given to a present exciting episode with a contracting envelope (evidenced by inverse P Cygni type profiles) of the LBV prototype S Dor. ESA

**N91-17866#** Trieste Univ. (Italy). Dipartimento di Astronomia.
**ABUNDANCES IN CHEMICALLY PECULIAR AND NORMAL A-TYPE STARS**
R. Faraggiana and M. Gerbaldi (Institut d'Astrophysique, Paris, France ) *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 39-48 (For primary document see N91-17861 09-90)
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Determinations of abundances with a particular emphasis on those derived from UV spectra are examined. These determinations are greatly improved for some light elements. A large number of UV unidentified lines are due to Fe II. The abundances of heavy elements need to be revised in the light of these observations. A large spread of abundances are observed in stars with similar parameters. Non solar abundances (both higher and lower than the solar ones) characterize an increasing number of dwarf A-type stars and seem to distinguish all the slow rotators. NLTE effects are included in the analyses, but are not sufficient to explain the global behavior derived from observations. ESA

**N91-17867#** Oxford Univ. (England). Dept. of Theoretical Physics.
**CHROMOSPHERES OF COOL STARS**
G. M. Harper *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 49-60 (For primary document see N91-17861 09-90)
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In the 12 years since the launch of the International Ultraviolet Explorer (IUE) understanding of stellar chromospheres has developed significantly because of the large range of stars that can be studied at both high and low resolution. A few topics are discussed which are important in understanding the structure of cool star chromospheres and which have developed with the help of IUE. Some examples of how calculations using model chromospheres help to confirm proposed photoexcitation mechanisms are presented. ESA

**N91-17868#** Lund Observatory (Sweden).
**STELLAR ACTIVITY CYCLES**
Dainis Dravins *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 61-64 Sponsored by Swedish Natural Science Research Council, Stockholm and Swedish Board for Space Activities (For primary document see N91-17861 09-90)
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Observed features of solar and stellar activity cycles are summarized, and some outstanding problems are discussed. Besides the 11 year sunspot cycle and the 22 year magnetic one, many other changes are seen on the Sun. The corona changes its solar wind velocity, density structure, and the number of x ray bright points. The chromosphere has varying ultraviolet and radio fluxes, changes in spectral line profiles, and in the frequency of flares. The photosphere changes its magnetic field patterns and the granulation structure. For the deeper layers, there may be changes in the temperature gradient, and in oscillation frequencies. All these changes are not in phase with one another. Challenges to understanding the solar cycle are discussed. They include possible magnetic flux variation, changes in the deep layers, and activity in the ancient Sun together with the (in)stability of the cycle period. Chromospheric cycles are observed: in ordinary dwarf stars; of the irradiance in spotted stars, and possibly of the flare frequency in flare stars. The detection of magnetic field cycles, of cycles in giant stars, and the imaging of starspots throughout a cycle are discussed. ESA

**N91-17869#** Hamburger Sternwarte G.m.b.H. (Germany, F.R.).
**WINDS IN COOL STARS**
R. Baade *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 65-72 (For primary document see N91-17861 09-90)
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After twelve years of operation the IUE (International Ultraviolet

Explorer) satellite continues to be influential in the field of cool star atmospheres. Ultraviolet spectroscopy provides powerful methods for inferring the physical properties of the outer layers (chromospheres, coronae, and winds) of these stars. Several empirical and semi empirical techniques developed to extract as much quantitative physical information as possible from high dispersion IUE spectra are described. The fundamentals of these methods are discussed and studies based on the binary technique are described. Aur type systems, consisting of a G - M giant or supergiant and a main sequence B star, can be used to advantage in evaluating mass loss rates and other wind parameters. ESA

**N91-17870*#** Villanova Univ., PA.
**WHAT WE LEARN FROM ECLIPSING BINARIES IN THE ULTRAVIOLET**
Edward F. Guinan *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 73-86 (For primary document see N91-17861 09-90)
(Grant NAG5-382)
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Recent results on stars and stellar physics from IUE (International Ultraviolet Explorer) observations of eclipsing binaries are discussed. Several case studies are presented, including V 444 Cyg, Aur stars, V 471 Tau and AR Lac. Topics include stellar winds and mass loss, stellar atmospheres, stellar dynamos, and surface activity. Studies of binary star dynamics and evolution are discussed. The progress made with IUE in understanding the complex dynamical and evolutionary processes taking place in W UMa-type binaries and Algol systems is highlighted. The initial results of intensive studies of the W UMa star VW Cep and three representative Algol-type binaries (in different stages of evolution) focused on gas flows and accretion, are included. The future prospects of eclipsing binary research are explored. Remaining problems are surveyed and the next challenges are presented. The roles that eclipsing binaries could play in studies of stellar evolution, cluster dynamics, galactic structure, mass luminosity relations for extra galactic systems, cosmology, and even possible detection of extra solar system planets using eclipsing binaries are discussed. ESA

**N91-17871#** Eidgenoessische Technische Hochschule, Zurich (Switzerland). Inst. of Astronomy.
**TWELVE YEARS IN THE LIFE OF SYMBIOTIC STARS**
H. Nussbaumer *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 87-94 (For primary document see N91-17861 09-90)
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Ways in which IUE (International Ultraviolet Explorer) brought new life to research in symbiotic stars are reviewed. IUE absolute calibrated spectra cover a wavelength domain which is crucial for investigating the nebula associated with these objects. Its uninterrupted observing record provides a reasonable basis for investigating the evolution of the slow outbursts in symbiotic novae and the behavior of the non nova symbiotics. The policy of a public archive, open to anyone after a chasse gardee of six months, has been of enormous benefit to those who try to find what is common to symbiotics and what is individual to each object. Those points where IUE helped to gain better insight into the symbiotic phenomenon are outlined. The hot component in the double star system and nova like events are given special attention. ESA

**N91-17872#** Cambridge Univ. (England). Inst. of Astronomy.
**IUE OBSERVATIONS OF DWARF NOVAE**
T. Naylor *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 95-100 (For primary document see N91-17861 09-90)
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Some IUE (International Ultraviolet Explorer) observations, and advances in theoretical understanding of the UV spectra of dwarf novae made in the last half decade are described. Quiescent spectra during the rise to outburst and observations of orbital modulations are given particular attention. ESA

**N91-17873*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
**THE IMPACT OF IUE ON STUDIES OF THE NOVA OUTBURST: 1986 TO 1990**
Sumner G. Starrfield (Arizona State Univ., Tempe.) *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 101-107 Sponsored in part by DOE (For primary document see N91-17861 09-90)
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Developments in understanding the nova outbursts that have occurred since the IUE (International Ultraviolet Explorer) meetings in 1986 and 1988 are outlined. Those developments that have occurred as a direct result of studies with the IUE satellite are emphasized. These involve the four outbursts that occurred in the large Magellanic cloud, the numerous recurrent novae outbursts, and a number of archival studies. As a direct result of IUE studies done since 1986, it is shown that fast novae become super Eddington at maximum, that many novae decline at the same rate, and that neon novae may be more numerous than previously thought. In addition, it is shown that there are differences in the ourburst characteristics between recurrent novae with giant secondaries and those with compact secondaries. ESA

**N91-17874*#** Harvard-Smithsonian Center for Astrophysics, Cambridge, MA.
**UV OBSERVATIONS OF X RAY BINARIES**
John C. Raymond *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 109-115 (For primary document see N91-17861 09-90)
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IUE (International Ultraviolet Explorer) has observed both high and low mass x ray binaries throughout its life. The UV spectra of high mass systems reveal the nature of the massive companion star and the effects of the x ray illumination of the stellar wind. In loss mass systems, the x ray illuminated disk or companion star dominates the UV light. System parameters and the characteristics of the accretion disk can be inferred. ESA

**N91-17875*#** Rice Univ., Houston, TX. Dept. of Space Physics and Astronomy.
**EMISSION LINE NEBULAE IN THE MAGELLANIC CLOUDS**
Reginald J. Dufour *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 117-123 (For primary document see N91-17861 09-90)
(Grant NAG5-262)
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H II regions, planetary nebulae, and supernova remnants in the large and small Magellanic clouds have been favored targets among all galactic and extragalactic emission nebulae for study with the IUE satellite due to their known distances and low line of sight extinction. Several of the major results arising from successful IUE (International Ultraviolet Explorer) observations of these three types of emission nebulae in the clouds are presented. Carbon abundances in the H II regions from UV emission lines with implications regarding the chemical evolution of the clouds and stellar origins of these elements are discussed. The UV spectral characteristics of several evolved and young SNRs in the clouds with comparisons made to similar objects in the Galaxy and other nearby galaxies are discussed. CNO abundance variations among planetary nebulae and characteristics of their central stars with emphasis on the new insights provided regarding PN formation and C-N nucleosynthesis during the various AGB dredge-up phases are discussed. ESA

**N91-17876#** European Space Agency, Paris (France). Astrophysics Div.
**THE ULTRAVIOLET SAGA OF SN 1987A**
Roberto Gilmozzi (Consiglio Nazionale delle Ricerche, Frascati, Italy ) *In its* Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 125-132 (For primary document see N91-17861 09-90)
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IUE (International Ultraviolet Explorer) observations of SN 1987A have provided an unprecedented insight into the supernova phenomenon and the stellar evolution stages immediately preceding it. The most significant contributions, beginning with an overview of the earlier results are outlined. Identification of the progenitor star, study of the interstellar medium towards the large Magellanic cloud, identification of the species responsible for the UV absorption spectrum and its evolution, and discovery of the narrow emission lines from the circumstellar shell are outlined. Spectral evolution and its implications for the site of dust formation and the UV contribution to the late bolometric light curve are outlined. Evolution of narrow emission lines and the derived constraints for a model of the shell are discussed. Hints of the detection of a UV light echo of the explosion, and determination of the reddening towards stars 2 and 3, based on their UV spectrum rather than on optimal photometry are discussed. ESA

**N91-17877*#** Princeton Univ. Observatory, NJ.
**DYNAMICS OF THE INTERSTELLAR MEDIUM**
Edward B. Jenkins *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 133-141 (For primary document see N91-17861 09-90)
(Grant NAG5-616)
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An extraordinarily rich assortment of electronic transitions of atoms and ions at ultraviolet wavelengths can be exploited to probe the behavior of interstellar gases in different contexts. The Copernicus and IUE (International Ultraviolet Explorer) satellites are used to investigate dynamical phenomena and important physical interactions which develop in separate phases of the medium. Insights on the establishment and overall properties of the mechanical energy created by stellar winds and supernova explosions at specific locations are outlined. Investigations of how multiple sources of energy move the gas and mold its structure over both small and large scales are outlined. ESA

**N91-17878#** Cambridge Univ. (England). Inst. of Astronomy.
**ARE QUASARS DIFFERENT**
R. F. Carswell *In* ESA, Evolution in Astrophysics: IUE Astronomy in the ERA of New Space Missions Aug. 1990 p 143-145 (For primary document see N91-17861 09-90)
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The properties of quasars and Seyfert galaxies are discussed, with particular reference to differences which may be fundamental to the nature of the objects. While there is now strong evidence that radio loud and radio quiet objects are from distinct populations, it appears that the only significant difference between active galaxies and quasars is one of scale: quasars are bigger, brighter and further away. ESA

**N91-17879#** Observatoire de Paris-Meudon (France).
**EXPERIENCE WITH AN HEROIC PROPOSAL: THE NGC 5548 INTERNATIONAL WATCH WITH IUE**
D. Alloin *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 147-151 (For primary document see N91-17861 09-90)
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Results from an 8 month campaign of observations with IUE (International Ultraviolet Explorer) of the variable active nucleus at the heart of the galaxy NGC 5548 are presented. The project aims at deriving the size and structure of emitting regions which surround the massive black hole and accretion disc system thought to be responsible for the large energy release in NGC 5548. The entire project, conducted from late 1987 to early 1990 and involving international collaboration, is described. ESA

**N91-17880#** Osservatorio Astronomico, Capodimonte, Naples (Italy).
**THE UV PROPERTIES OF NORMAL GALAXIES**
Giuseppe Longo *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 153-158 (For primary document see N91-17861 09-90)
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The nature of the hot stellar component detected by ultraviolet observations in early type galaxies is discussed. Particular emphasis is put on the observational evidences for ongoing stellar formation. Some new correlations, arising from the comparison of IRAS (Infrared Astronomy Satellite) and IUE (International Ultraviolet Explorer) data are presented. The Hubble Space Telescope, with its unique ultraviolet imaging capabilities, is predicted to help solve many problems. It is concluded, however, that to have the final word on the UV properties of early type galaxies the next generation of space telecopes is needed. ESA

**N91-17881#** Nordisk Inst. for Teoretisk Atomfysik, Copenhagen (Denmark).
**STAR BURSTS AND GIANT H II REGIONS**
B. E. J. Pagel *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 159-165 (For primary document see N91-17861 09-90)
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Massive star formation bursts occur in a variety of galactic environments and can temporarily dominate the light output of a galaxy even when a relatively small proportion of its mass is involved. Inferences about their ages, the IMF and its dependence on chemical composition are still somewhat wobbly owing to an excess of unknowns, but certain things can be deduced from emission spectra of associated H II regions when due regard is paid to the effects of chemical composition and ionization parameter. Ionization parameters and effective temperatures of exciting stars, at any given oxygen abundance, are anticorrelated with the abundance, and the second effect suggests an increasing proportion of more massive stars at lower abundances, although this is not yet satisfactorily quantified. A few blue compact galaxies could be very young, but it is equally possible that there is an older population of low surface brightness. Some giant H II regions may be self polluted with nitrogen and helium due to winds from massive stars in the associated burst. ESA

**N91-17882#** European Space Agency, Paris (France).
**ESA'S HORIZON 2000 PROGRAMME**
R. M. Bonnet *In its* Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 167-173 (For primary document see N91-17861 09-90)
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The Horizon 2000 program, ESA's long term program in space science, is outlined. The program was initiated in 1984 and is based on a series of large, medium and small missions in space astronomy and exploration of the solar system. An update of the missions already in orbit and those under development is presented. The status of the long term missions is described. A schedule is given for the launch and implementation of these missions. ESA

**N91-17883*#** National Aeronautics and Space Administration, Washington, DC.
**THE ASTROPHYSICS PROGRAM AT THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA)**
C. J. Pellerin *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 175-182 (For primary document see N91-17861 09-90)

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Three broad themes characterize the goals of the Astrophysics Division at NASA. These are obtaining an understanding of the origin and evolution of the universe, the fundamental laws of physics, and the birth and evolutionary cycle of galaxies, stars, planets and life. These goals are pursued through contemporaneous observations across the electromagnetic spectrum with high sensitivity and resolution. The strategy to accomplish these goals is fourfold; the establishment of long term space based observatories implemented through the Great Observatories program; attainment of crucial bridging and supporting measurements visa missions of intermediate and small scope conducted within the Explorer, Spacelab, and Space Station Attached Payload Programs; enhancement of scientific access to results of space based research activities through an integrated data system; and development and maintenance of the scientific/technical base for space astrophysics programs through the research and analysis and suborbital programs. The near term activities supporting the first two objectives are discussed. ESA

**N91-17884#** Tokyo Univ. (Japan). Inst. of Space and Astronautical Science.

**SPACE RESEARCH PROGRAMME OF JAPAN c88**

Y. Tanaka *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 183-187 (For primary document see N91-17861 09-90)

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The Institute of Space and Astronautical Science (ISAS) serving the whole of the space science community of Japan is described. It possesses its own launch capability, and provides frequent opportunities for modest missions in various disciplines. The on going and future space programs of Japan are outlined, and some details of space astrophysics missions in the fields of solar physics, x ray astronomy, infrared astronomy and radio astronomy are presented. ESA

**N91-17885*#** California Univ., Berkeley. Center for EUV Astrophysics.

**THE EXTREME ULTRAVIOLET EXPLORER**

Stuart Bowyer and Roger F. Malina *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 189-197 (For primary document see N91-17861 09-90)

(Contract NAS5-29298)

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The Extreme Ultraviolet Explorer (EUVE) mission, currently scheduled for launch in September 1991, is described. The primary purpose of the mission is to survey the celestial sphere for astronomical sources of Extreme Ultraviolet (EUV) radiation. The survey will be accomplished with the use of three EUV telescopes, each sensitive to a different segment of the EUV band. A fourth telescope will perform a high sensitivity search of a limited sample of the sky in the shortest wavelength bands. The all sky survey will be carried out in the first six months of the mission and will be made in four bands, or colors. The second phase of the mission, conducted entirely by guest observers selected by NASA, will be devoted to spectroscopic observations of EUV sources. The performance of the instrument components is described. An end to end model of the mission, from a stellar source to the resulting scientific data, was constructed. Hypothetical data from astronomical sources processed through this model are shown. ESA

**N91-17886*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.

**THE LYMAN FAR ULTRAVIOLET SPECTROSCOPIC EXPLORER MISSION**

George Sonneborn *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 199-205 (For primary document see N91-17861 09-90)

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The Lyman-FUSE (Far Ultraviolet Spectroscopic Explorer) mission selected in 1989 for definition and development for flight is described. FUSE will obtain spectra in the 912 to 1250 angstrom region with unprecedented sensitivity. This spectral interval is extraordinarily rich in strong atomic and molecular transitions, including the Lyman series of hydrogen and deuterium, molecular hydrogen (H2 and HD) and the strong transitions of important ions such as N I to III, C I to IV, P II to V, O VI and S III to VI. FUSE will bridge the spectral gap between Hubble Space Telescope and the x ray regime with an additional moderate resolution spectroscopic capability covering 100 to 912 angstroms. ESA

**N91-17887#** Computer Sciences Corp., Lanham, MD. Science Programs.

**IUE FINAL ARCHIVE**

Joy Y. Nichols-Bohlin *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 207-213 (For primary document see N91-17861 09-90)

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The IUE (International Ultraviolet Explorer) project has embarked on a major effort to improve the processing method used for IUE data for the production of the final IUE archive. This archive which contains nearly 70,000 images, will be reprocessed in its entirety to create a homogeneous data set for future investigators. The software used to process the data for the present archive (IUESIPS) has undergone several changes and enhancements since its launch, and the archive reflects these discontinuities. Many new techniques for image processing are now available which were not available in 1976, when the current system was designed. The new processing method for the creation of the final archive is described. It will allow a significant improvement of the signal to noise ratio of the processed data, resulting largely from a more accurate (and only one) resampling of the data. ESA

**N91-17888#** University Coll., Cardiff (Wales). School of Mathematics.

**INTERPRETATION OF COMET HALLEY'S DUST CONTINUUM IN THE UV**

Max K. Wallis and N. Chandra Wickramasinghe *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 217-219 (For primary document see N91-17861 09-90)

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Mie theory calculations show that the UV scattering from a distribution of dust grains varies strongly with wavelength, depending on both the composition and the size distribution. It is not acceptable to use a scaled and reddened spectrum over the IUE (International Ultraviolet Explorer) long wavelength range to simulate the scattered continuum. In identifying wavelengths where the molecular contamination is low, March 1986 IUE data on Halley's comet is examined. The 1900 to 2900A data would exclude substantial contribution from ice or olivine grains, but are quite compatible with predominantly organic and probably porous dust grains with size distribution as detected by the comet space probes. ESA

**N91-17889#** University Coll., Cardiff (Wales). School of Mathematics.

**IUE OBSERVATIONS OF COMET OKAZAKI-LEVY-RUDENKO (1989r)**

Max K. Wallis, J. C. Zarnecki, and S. P. Deshpande (Kent Univ., Canterbury, England ) *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 221-222 Sponsored in part by Science Research Council, England and Kent Univ. (For primary document see N91-17861

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IUE (International Ultraviolet Explorer) observations of comet Okazaki-Levy-Rudenko (1989r) carried out on 14, 19 and 29 Dec. 1989 are described. Preliminary analysis was carried out, including derivation of the H2O production rates on the three dates. CO2+ is found to be relatively strong, particularly on 19 Dec., while a sunwards/tailwards anisotropy in OH(0-0) emission is also seen on this date. ESA

**N91-17890#** University Coll., Cardiff (Wales). School of Mathematics.
**OBSERVATIONS OF COMET BRORSEN-METCALF AND COMPARISONS WITH HALLEY**
Max K. Wallis, David P. Hughes, and Iwan P. Williams (London Univ., England ) *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 223-225 Sponsored in part by Science Research Council, England (For primary document see N91-17861 09-90)
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IUE (International Ultraviolet Explorer) observations of comet Brorsen-Metcalf in Jul./Aug. 1989 showed an OH gas production 10 to 12 times weaker than comet Halley at a similar distance (1AU) pre-perihelion and weakening anomolously as the comet came in. Ions and CS also weakened and more strongly, despite brightening of the nuclear region in the visual. In contrast to Halley, the dust continuum was very weak. It is suggested that the source of the gases is the coma of large grains that become depleted in volatiles, rather than the conventional icy nucleus with active regions like Halley. ESA

**N91-17891*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
**A SEARCH FOR BETA PICTORIS ANALOGS**
Kwang-Ping Cheng, C. A. Grady, Frederick C. Bruhweiler (Catholic Univ. of America, Washington, DC.), and Yoji Kondo *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 227-230 (For primary document see N91-17861 09-90)
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The results are presented of the survey of known shell stars detected by the Infrared Astronomy Satellite (IRAS) at sufficient bandpasses to permit evaluation of the nature of the infrared excess, and having archival International Ultraviolet Explorer (IUE) high dispersion spectra suitable for identifying stars with infalling circumstellar plasma. Detection of infall in shell stars with infrared signatures of circumstellar dust is described. One star which shows infalling plasma, but apparently no circumstellar dust is described. The implications for the understanding of Beta Pictoris and similar systems are discussed. ESA

**N91-17892#** Consiglio Nazionale delle Ricerche, Frascati (Italy). Ist. di Astrofisica Spaziale.
**MULTIFREQUENCY BEHAVIOUR OF THE T TAURI STAR RU LUPI**
F. Giovannelli, C. Rossi, L. Errico, A. A. Vittone, G. S. Bisnovatyi-Kogan, V. G. Kurt, E. K. Sheffer, and S. A. Lamzin (Academy of Pedagogical Sciences of the USSR, Moscow.) *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 231-234 (For primary document see N91-17861 09-90)
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A long term campaign of multifrequency observations of RU Lupi, from x ray to IR, performed in order to clarify the validity of the current models of T Tauri like stars is described. ASTRON and IUE (International Ultraviolet Explorer) satellites and ESO telescopes are used. The analysis of RU Lupi energy distribution monitoring shows strong UV and IR excesses and a large variability in the continuum. The amplitude of the variations decreases from the UV to the IR range. Weaker variations in the line intensities are detected. In the IUE range a positive correlation between the integrated flux of the continuum and the contribution of the emission lines is found. A positive correlation is found, in the optical range, between luminosity and its variation which are mainly due to a strong photospheric and chromospheric activity. The most promising explanation for the very low x ray fluxes detected in RU Lupi is that the hot chromosphere forms as a result of the disk accretion from the protostellar cloud onto the young star and only minor fraction of the energy dissipated in this process goes into x ray radiation. ESA

**N91-17893#** Trieste Univ. (Italy). Dept. of Astronomy.
**LOW RESOLUTION ULTRAVIOLET SPECTRA OF HERBIG Ae-Be STARS**
Margherita Hack and Conrad Boehm (Osservatorio Astronomico, Trieste, Italy ) *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 235-239 (For primary document see N91-17861 09-90)
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The low resolution UV spectra of the Herbig stars observed with IUE (International Ultraviolet Explorer) is described and compared with results obtained by Finkenzeller and Mundt (1984) from the optical spectra of the same stars. The interstellar reddening from the depression at 2200 is compared with the dereddened flux distribution of several standard stars and with the theoretical spectra computed by Kurucz to derive their distances from the relation interstellar reddening versus distance modulus of normal stars in the same angular region of each Herbig star. Their position in the HR diagram can be found this way and their line spectrum identified. ESA

**N91-17894*#** Colorado Univ., Boulder. Center for Astrophysics and Space Astronomy.
**PRELIMINARY INTERPRETATION OF THE Mg II VARIABILITY OF L2 PUPPIS**
Edward W. Brugel, Lee Anne Willson, and George Bowen (Iowa State Univ. of Science and Technology, Ames.) *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 241-246 (For primary document see N91-17861 09-90)
(Contract NAS5-28731; NAG5-350; NAG5-707; NAGw-1364)
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L2 Pup is perhaps the brightest SRb/Mira variable in the sky, with extreme variability from 2.6 to 6.2 magnitudes visually and a normal variation between 3.5 to 5.5. More than 60 percent of its cycles show large amplitude (2 magnitude) variation that is Mira like; however at intervals of 40 to 50 cycles it goes into a phase of smaller amplitude variability. One of the small amplitude episodes began in 1986 while L2 Pup was being observed with IUE (International Ultraviolet Explorer) as part of the monitoring program. During the first three observed cycles, Mg II emission in L2 Pup behaved in a manner similar to that in other normal Miras, and L2 Pup's light curve was also Mira like. However, during the fourth cycle there was an abrupt change in the Mg II emission, although the visual light curve remained normal through that cycle. In the next cycle the light curve also decreased in amplitude, and the Mg II emission remained anomalously low. ESA

**N91-17895*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
**SPECTRAL CLASSIFICATION OF B STARS IN THE ULTRAVIOLET**
Janet Rountree and George Sonneborn *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 247-250 (For primary document see N91-17861 09-90)
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A set of criteria developed for the classification of B stars

from ultraviolet spectra alone, using MK standards drawn from the optical region is described. The observational material consists of 100 archival high dispersion spectra obtained by the SWP (Short Wavelength Prime) camera on the IUE (International Ultraviolet Explorer) spacecraft. Only photospheric absorption lines are used as classification criteria. The C IV, SI IV and N V lines, which in early B stars originate in the stellar wind, are not used in the two dimensional spectra type luminosity classification, but the appearance of these lines is compared with the standard stars, and some anomalies noted. On the whole, the ultraviolet spectral types are very consistent with the optical MK types, implying that it is possible to do a two dimensional spectral classification in the ultraviolet without any knowledge of the optical spectrum. ESA

**N91-17896#** Osservatorio Astronomico, Trieste (Italy).
**A COMPARATIVE STUDY OF B AND Be STARS IN THE UV: NEW EVIDENCE OF A NEAR-EQUATORIAL ORIGIN OF THE SIIV 1400 AND C IV 1500 FEATURES IN Be STARS**
P. L. Selvelli and S. Monai (Trieste Univ., Italy ) *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 251-253 (For primary document see N91-17861 09-90)
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A study of the UV spectra of 46 Be and 38 B stars of all subtypes reveals the presence of systematic differences in the SI IV and C IV features between the two classes of objects. Plots of the equivalent widths of Si IV and C IV against vsini show dramatic differences. In B stars there is a separation line between the Si IV and C IV values and no dependence at all on vsini, while in Be stars the C IV and SI IV points are mixed and there is a clear dependence of the W's on vsini. Wind features are very rare in B stars, while most of the Be stars show the presence of outflow, with edge velocities up to -1200 km/s. In early type Be stars there is a correlation between velocity edge and vsini in the sense that the maximum outflow velocity associated with each vsini increases with vsini. The implications of these findings for the modeling of Be stars are discussed. ESA

**N91-17897#** Observatoire de Paris-Meudon (France).
**ATLAS OF FAR UV AND OPTICAL SPECTRA OF Be STARS**
Vera Doazan, G. Sedmak, Michael Barylak, and L. Rusconi (Trieste Univ., Italy ) *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 255-256 (For primary document see N91-17861 09-90)
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An atlas based on IUE (International Ultraviolet Explorer) high resolution spectra of the Be stars and their Balmer emission line profiles published by ESA in 1990 is described. It is intended to serve as a tool for future research and planning of both ground based and spaceborne observations. It contains information about 170 Be stars. Details on the compilation of this atlas together with some outstanding examples of Be star variability discovered during its preparation are presented. ESA

**N91-17898*#** University of Southern California, University Park. Space Sciences Center.
**SHORT-TERM FUV FLUX VARIABILITY AND PHASE-DEPENDENT WINDS IN Be STARS**
G. J. Peters, J. R. Percy, H. F. Henrichs, D. R. Gies, and D. McDavid (Texas Univ., San Antonio.) *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 257-260 (For primary document see N91-17861 09-90)
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FUV (Far Ultraviolet) light curves and the behavior of the C IV wind line versus phase are discussed for four Be stars. The IUE (International Ultraviolet Explorer) data acquired during three multiwavelength campaigns aimed at determining the cause for short term optical light variability in Be stars and whether it is linked with the mass loss mechanism is presented. The observations confirm that it is a modulation in the star's photospheric temperature that causes the flux variability. A phase dependent variation is seen in the equivalent width and profile in the C IV wind line. The wind absorption tends to be strongest at maximum light and in a Be shell star the absolute flux of its C IV emission component appears to be anticorrelated with the absorption strength and the level of the FUV flux. The observations suggest that nonradial pulsations are responsible for the photometric variability and the generic model of a star pulsating in a sectorial mode. ESA

**N91-17899#** Osservatorio Astronomico, Trieste (Italy). Gruppo Nazionale Astronomia.
**THE FEATURES AT 130.55 AND 130.95 nm IN B TYPE STARS**
F. Castelli and J. Singh (Trieste Univ., Italy ) *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 261-265 (For primary document see N91-17861 09-90)
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Striking features centered at 130.55 and 130.95 nm are observable in B type stars. In order to investigate to what extent the lines of the UV multiplet 13.04 of SI II at 130.5592, 130.9453, and 130.975 nm contribute to the broad absorptions, the observed features are compared with the computed ones for two normal stars (Her (B3 IV) and Ceti (B7 IV)) and two Si weak peculiar stars (Feige 86 (B3 V) and HR 6000 (B6 V)). By using the Si abundances derived from the Si II lines UV multiplet 4 and the autoionization broadening constant given by Artru and Lanz (1987), good agreement between observations and computations for all four stars is found. This means that when broad features are observed in B types stars, they are mostly due to the lines of Si II (13.04), which all three autoionize in stellar atmospheres, as predicted by Underhill (1981). ESA

**N91-17900#** Observatoire de Paris-Meudon (France).
**ROTATIONAL AND RAPID FLUX VARIATIONS OF 21COM IN THE ULTRAVIOLET**
C. Megessier and R. Monier (European Space Agency. ESA Tracking Station, Madrid, Spain ) *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 267-269 (For primary document see N91-17861 09-90)
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In the ultraviolet range, the cool Ap star 21Com shows variability over its rotation period and also on much shorter timescales. The spectrophotometric variability of 21Com in the ultraviolet was observed with IUE (International Ultraviolet Explorer) on several occasions in 1978/79, 86/87, and 89. Results of an FES light curve obtained in 1986/87 and 1989 are compared with the light curve published by Kreidl et al in 1990. ESA

**N91-17901#** European Space Agency. ESA Tracking Station, Madrid (Spain). IUE Observatory.
**THE ULTRAVIOLET VARIATIONS OF 78VIR**
R. Monier *In its* Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 271-272 (For primary document see N91-17861 09-90)
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Over its 3,722 days rotation period, 78Vir exhibits variations particularly large in the far ultraviolet. The 78Vir is the first star in which a stellar magnetic field was detected through Zeeman splitting of optical lines. Preliminary results on phase resolved spectrophotometry of 78Vir with IUE (International Ultraviolet Explorer) are presented. ESA

**N91-17902#** Observatoire de Paris-Meudon (France).
**IS THE MAGNETIC AP STAR 21 PER AN ECLIPSING BINARY**
C. Megessier and M.-C. Artru (Ecole Normale Superieure, Lyon, France ) *In* ESA, Evolution in Astrophysics: IUE Astronomy in

the Era of New Space Missions Aug. 1990 p 273-274 (For primary document see N91-17861 09-90)
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Line variations of the UV spectra of the Ap star 21 Per are observed between eight phases of its rotational period. Si II varies in opposition with CII and S I. The continuum is shown to be variable. The measured integrated flux over several ultraviolet wavelength domains plotted according to the phase suggests a possible eclipsing binarity. Dependance of stellar effective temperature on the gravitational settling is looked for. IUE (International Ultraviolet Explorer) high resolution spectra are used in analyzing one rotational period. Although only six UV points are obtained, the curve looks like that of an eclipsing binary. ESA

**N91-17903#** Lausanne Univ. (Switzerland). Inst. d'Astronomie.
**NITROGEN ABUNDANCES IN CHEMICALLY PECULIAR STARS**
T. Lanz and M.-C. Artru (Ecole Normale Superieure, Lyon, France) *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 275-278 Sponsored in part by Swiss National Foundation for Scientific Research, Meikirch (For primary document see N91-17861 09-90)
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Nitrogen abundances are derived for 9 Ap stars and for two comparison stars from high resolution IUE (International Ultraviolet Explorer) spectra. LTE synthetic spectra are calculated in three spectral regions around low excitation N I multiplets, taking into account the new atomic data for iron peak elements recently computed by Kurucz. The two comparison stars are found to be mildly nitrogen deficient. The results suggest that Ap stars have large nitrogen underabundances. The results are compared with the recent work of Roby and Lambert, who deduced CNO abundances from high excitation lines in the red spectrum. The importance of CNO abundances to understand the origin of the chemical anomalies of Ap stars is outlined. ESA

**N91-17904#** University Coll., London (England). Dept. of Physics and Astronomy.
**CARBON AND NITROGEN ABUNDANCES IN HgMn STARS**
K. C. Smith and M. M. Dworetsky *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 279-282 (For primary document see N91-17861 09-90)
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The abundances of carbon and nitrogen in the atmospheres of a sample of normal late B and HgMn stars is determined using archival IUE spectra. Most HgMn stars are found to exhibit similar carbon abundances to normal stars, although three of the HgMn stars are found to be grossly carbon deficient. Measured equivalent widths and inferred abundances demonstrate that the HgMn stars are all significantly nitrogen deficient. These observations provide a useful test for radiative diffusion theory as an explanation of the HgMn phenomenon. ESA

**N91-17905*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
**THE VERY HIGH ROTATORS IN THE LATE-B AND EARLY-A STARS: SHELL STARS WITH Si IV AND C IV FEATURES THE CASE OF HD 119921**
R. FreireFerrero, Frederick C. Bruhweiler, and C. A. Grady (Catholic Univ. of America, Washington, DC.) *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 283-286 Sponsored in part by NATO, and CNRS, Verrieres-le-Buisson, France (For primary document see N91-17861 09-90)
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Study of several stars in the late B and early A spectral types shows that very high rotators are associated with shell characteristics (sometimes not detected at all in the visible spectra) and also with C IV and some Si IV spectral absorption features which can be explained by circumstellar phenomena superimposed over stellar metallic blends. These particularities are evidenced by comparison with other spectra of low and high rotators in the same spectral range. HD 119921, a star with similar characteristics to the other ones of the sample, is given special attention. A possible scenario is suggested to explain the observed superionization features. ESA

**N91-17906#** Trieste Univ. (Italy). Dipartimento di Astronomia.
**THE LAMBDA BOO STARS**
R. Faraggiana and M. Gerbaldi (Institut d'Astrophysique, Paris, France ) *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 287-288 (For primary document see N91-17861 09-90)
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The origin of Lambda Boo phenomena are not clear. Careful candidate selection carried out in order to develop a clear definition of the theoretical problems is outlined. The usefulness of IUE (International Ultraviolet Explorer) low resolution short wavelength range for classifying Lambda Boo stars is shown. The UV criteria, while more powerful than those used in the optical range, do not allow an unambiguous selection of Lambda Boo stars. Kinematical properties are shown to be necessary to make a clear distinction between them and population II objects. ESA

**N91-17907#** University Coll., London (England). Dept. of Physics and Astronomy.
**NEW RESULTS OF THE UV VARIABILITY OF THE WR STARS HD 50896 AND HD 192163**
N. Saint-Louis, A. J. Willis, L. J. Smith, C. D. Garmany, and P. S. Conti (Joint Inst. for Lab. Astrophysics, Boulder, CO.) *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 289-292 (For primary document see N91-17861 09-90)
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A preliminary analysis of two new datasets of high resolution IUE (International Ultraviolet Explorer) spectra for the Wolf-Rayet (WR) stars HD 50896 and HD 192163 is presented. Extensive variability is found in the P Cygni profiles of N IV lambda 1718, V IV lambda 1550 and He II lambda 1640 for HD 50896 with a recurrence timescale of 1 day. These observations constitute one of the best examples so far of variability in the ionization, density or velocity structures of WR winds. The new spectra for HD 192163 do not show much variability but are significantly different from spectra obtained for previous studies, emphasizing the epoch dependency and intrinsic origin of the ultraviolet spectral variations of this star. ESA

**N91-17908#** Rice Univ., Houston, TX. Dept. of Space Physics and Astronomy.
**CNO ABUNDANCE VARIATIONS IN THE TYPE I PLANETARY NEBULAE**
Reginald J. Dufour, Mark L. Mulrooney, and Donald K. Walter *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 293-296 (For primary document see N91-17861 09-90)
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Preliminary results of IUE (International Ultraviolet Explorer) and ground based observations of some 20 planetary nebulae of the He and N rich Peimbert type I class believed to originate from progenitor stars of the upper mass range which form PN are reported. IUE archives spectra of 9 objects are combined with new SWP (Short Wavelength Prime) and LWP (Long Wavelength Prime) spectra of 8 objects obtained during three observing runs in 1989 and 1990. Ground based spectra of several observed with the IUE during 1989 to 90 were taken at KPNO and CTIO with similar slit positions for accurate analysis of the more extended objects. Electron temperatures, densities, and ionic concentrations are derived from various UV optical line sets and used with direct

ionization diagnostics or photoionization models to derive total elemental abundances for C, N, O, etc. in each nebula. Graphs of correlations between concentrations of various elements in the group of Type I PN are shown. Correlations between C and N, O, and He are analyzed. ESA

**N91-17909#** Observatoire de Paris-Meudon (France).
**IMPLICATIONS ON STELLAR STRUCTURE/EVOLUTION OF THE OBSERVED ASSOCIATION BETWEEN ENERGY/MASS FLUXES AND MULTI-REGIONAL ATMOSPHERIC STRUCTURE**
Vera Doazan and Richard N. Thomas (Radiophysics, Inc., Boulder, CO.) *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 297-301 (For primary document see N91-17861 09-90)
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The thermodynamic basis for various theories of stellar internal structure and evolution is examined. Questioning of the basis due to results from the IUE (International Ultraviolet Explorer) decade of observations of stellar atmospheres is discussed. The thermodynamic character of the change from Emden to Eddington modeling is considered. Perturbation of Eddington type stellar structure and evolution is discussed. ESA

**N91-17910#** Princeton Univ. Observatory, NJ.
**CONTINUA OF B SUPERGIANTS IN THE LMC**
Edward L. Fitzpatrick *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 303-305 (For primary document see N91-17861 09-90)
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Intrinsic UV through visual energy distributions are determined for a sample of 38 B type supergiants in the Large Magellanic Cloud (LMC). Comparison of these energy distributions with Kurucz type (i.e., line blanketed, plane parallel, LTE) atmosphere models yields estimates of both the effective temperatures and surface gravities of the stars. From these, and the known distance of the LMC, the luminosities and masses are derived. Comparison of these results with the predictions of stellar evolution calculations suggests that the atmosphere models yield reasonable estimates of the physical parameters for the earliest B supergiants. At lower temperatures, the derived masses are systematically smaller (by as much as a factor of 3 for the latest B supergiants) than expected from stellar evolution models. The magnitude of the deviation increases with decreasing temperature. ESA

**N91-17911*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
**ON THE DISAPPEARANCE OF O I IN SOME HIGH-LUMINOSITY COOL STARS**
K. G. Carpenter, D. Norman, R. Robinson, J. L. Fernandez-Villacanas, C. Jordan, and P. Judge (Joint Inst. for Lab. Astrophysics, Boulder, CO.) *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 307-310 (For primary document see N91-17861 09-90)
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Far UV spectra and flux measurements of cool giant and supergiant stars, focusing on the O I (UV 2) and S I/Si II fluxes and their dependence on stellar parameters are presented. The de-reddened O I surface fluxes vary by factors of several hundred over the 11 stars in the sample and, at a given luminosity, decrease with decreasing effective temperature. No flux at all is detected in the three M supergiants observed to date. In contrast, the S I/Si II blend near 1810 angstrom is clearly detected in all the stars. Its strength generally increases with luminosity, but has little effective temperature dependence. Possible explanations for the behavior of O I include changes in the intensities of Lyman alpha and beta which excite the lines of S I and O I, respectively, as well as scattering and/or absorption of the O I flux in a dense, circumstellar gas shell. ESA

**N91-17912#** Valencia Univ. (Spain). Departimento de Matematica Aplicada y Astronomia.
**POSSIBLE VERY EXTENDED ENVELOPES AROUND RED SUPERGIANTS**
J. Suso, F. Querci, A. Talavera, M. Querci (Observatoire de Midi-Pyresnees, Toulouse, France ), and J. Fabregat *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 311-313 (For primary document see N91-17861 09-90)
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The effect of interstellar medium absorption is distinguished from circumstellar environment absorption for cool supergiants. It appears that the 2200A absorption feature should give an answer to this task. IUE observations are used in gaining a better understanding of the supergiant environment. The interstellar extinction laws have a characteristic shape and a maximum at 2200A. Whether or not this shape is the same in the environment of red supergiants is discussed. ESA

**N91-17913#** Centre National de la Recherche Scientifique, Verrieres-Le Buisson (France). Inst. d'Astrophysique Spatiale.
**THE CHROMOSPHERIC LYMAN-ALPHA CORE EMISSION OF ALTAIR**
R. FreireFerrero, S. Catalano, P. Goutebroze, and E. Marilli (Catania Astrophysical Observatory, Italy ) *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 315-318 Sponsored by DRCI-CNRS; CNR; Italian Ministry of Public Education; and NATO (For primary document see N91-17861 09-90)
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Following the first claim for the detection of the Lyman alpha emission from Altair, SWP IUE (Short Wavelength Prime International Ultraviolet Explorer) spectra had confirmed the existence of that chromospheric feature. To obtain the stellar Ly alpha core, the superimposed geocoronal Ly alpha emission is eliminated. Altair and the neighborhood sky are observed with the same exposure time at the same epoch: their difference gives a well defined Ly alpha profile without geocoronal contamination. The use of different methods allows obtention of a mean and well defined stellar core profile, showing a wide central Ly alpha interstellar absorption. These methods of data reduction are presented and the resulting profile is discussed. ESA

**N91-17914#** ST Systems Corp., Lanham, MD.
**AN IUE STUDY OF THE CHROMOSPHERES AND TRANSITION REGIONS OF F GIANT AND SUBGIANT STARS**
S. A. Drake and T. Simon (Hawaii Univ., Honolulu.) *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 319-321 (For primary document see N91-17861 09-90)
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The preliminary results of an investigation of the ultraviolet spectra of F giant and subgiant stars are presented. Emphasis is given to the higher luminosity stars. The giant stars are typically 1.5 to 2.0 M stars which are in the early stages of their post main sequence evolution, and are still in or have just left the instability strip. C II and C IV emission lines are detected in stars as blue as B - V = 0.28, the blue limit of the present survey. Between B - V = 0.28 and B - V = 0.52, the normalized fluxes in C IV show little variation. Neither line shows any functional dependence on rotation rate. ESA

**N91-17915#** Lund Observatory (Sweden).
**THE DISTANT FUTURE OF SOLAR ACTIVITY: A CASE STUDY OF BETA HYDRI** **c92**
Dainis Dravins, Peter Linde, T. R. Ayres, K. Fredga, G. Gahm, L. Lindegren, J. L. Linsky, B. Monsignori-Fossi, A. Nordlund, and T. Simon (Hawaii Univ., Honolulu.) et al *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 323 (For primary document see N91-17861

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The post main sequence evolution of non thermal processes in solar type atmospheres is studied through detailed comparisons of the current Sun with old solar type stars of known age, whose parameters can be interpreted in terms of perturbed solar models. Among the few such stars in the solar galactic neighborhood, Beta Hydri (HR 98, HD 2151; G2 4) stands out as a normal single star about 9 billion years old. Its proximity to the main sequence in the Hertzsprung-Russell diagram tells it originated from evolutionary tracks. Being the closest subgiant, it is a bright target, and permits detailed spectroscopic studies. ESA

**N91-17916*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
**A HIGH RESOLUTION ATLAS OF Mg II PROFILES**
R. Ewald, Joy Y. Nichols-Bohlin (Computer Sciences Corp., Lanham, MD.), and Yoji Kondo *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 325-330 (For primary document see N91-17861 09-90)
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An atlas of high dispersion Mg II profiles for standard stars of spectral types B0 through G9 is presented. The atlas contains plots of the Mg II profiles for approximately 65 stars and associated equivalent width measurements for both absorption and emission components, and the subordinate lines. The atlas is used to investigate systematic behavior of the Mg II profiles and correlation of the behavior with spectral classification. ESA

**N91-17917#** Hamburger Sternwarte G.m.b.H. (Germany, F.R.).
**THE ONSET OF COOL STELLAR WINDS INDICATED BY CIRCUMSTELLAR Mg II ABSORPTION COMPONENTS**
M. Huensch *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 331-333 (For primary document see N91-17861 09-90)
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A search for blue shifted Mg II absorption compositions that are considered to be reliable indicators of cool stellar winds is undertaken by means of IUE (International Ultraviolet Explorer) spectra of about 20 binary systems containing a cool giant and a hot main sequence star. Knowledge about the exact location in the HRD of the transition from hot coronae to cool stellar winds is obtained. The Mg II dividing line proposed by Stencel and Mullan could not be confirmed as an indicator of the onset of mass loss through cool stellar winds. Although the data base is too small to propose a new Mg II dividing line, the transition seems to take place between the two existing dividing lines in Ca II and Mg II. Preliminary mass loss rates for the giants in the binaries 58 Per and beta Sct are derived. ESA

**N91-17918#** Indiana Univ., Bloomington.
**CHROMOSPHERIC VARIATION AND PHASE RELATION IN M GIANTS Abstract Only**
H. R. Johnson, J. A. Estom, and R. R. Cadmus (Grinnell Coll., IA.) *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 335 Submitted for publication (For primary document see N91-17861 09-90)
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Chromospheric emission in the M-giant stars W Cyg (M5), NU Pav (M6), and Theta Aps (M7) was monitored over a three year period by means of IUE (International Ultraviolet Explorer). A wide range in variability for these three semi regular variable stars is found; in NU Pav the chromospheric emission has been relatively constant, while the others show variations of as much as a factor of 5. For W Cyg, simultaneously groundbased V photometry, which allows a study of the relative time behavior of regions which emit either lines or continuum is obtained. On occasion a clear phase lag is seen, yielding a more or less direct measurement of the distance between the photosphere and the chromosphere of the order of a new tens of millions of kilometers. Ramifications of this discovery are discussed. ESA

**N91-17919*#** Applied Research Corp., Landover, MD.
**CARBON AND NITROGEN ABUNDANCES IN THE SUPERGIANTS HD 93840 AND ZETA PER**
Derck Massa, Bruce Altner, David Wynne, and H. J. G. L. M. Lamers (Space Research Organization Netherlands, Utrecht.) *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 337-340 (For primary document see N91-17861 09-90)
(Contract NAS5-29301)
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The BN supergiant HD 93840 is shown to have the same temperature and surface gravity as the normal Bi Ib zeta Per. Differential abundance analysis of their C 4 and N 5 wind line profiles are found. The results are independent of the usual model atmosphere analyses and, therefore, a valuable check on them. Ratios for the C and N surface abundances in HD 93840 compared to Per of 1:10 and 4.6:1 are found respectively. By introducing a simple model for the compositions of both atmospheres the fraction of material in each atmosphere which has undergone CNO processing, more than 90 percent for HD 93840 and less than about 15 percent for zeta Per, is derived. ESA

**N91-17920*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
**THE INTRINSIC H I LYMAN-ALPHA LINE PROFILES OF LATE-TYPE STARS**
J. E. Neff, W. B. Landsman, J. A. Bookbinder, and J. L. Linsky (Joint Inst. for Lab. Astrophysics, Boulder, CO.) *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 341-344 Sponsored in part by National Research Council (For primary document see N91-17861 09-90)
(Grant NAG5-82)
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The Lyman-alpha line of neutral hydrogen is probably the most important cooling channel for chromospheric plasma in late-type stars, yet it is also the least studied major line in the far ultraviolet. The scattering of much of the stellar Lyman-alpha flux by interstellar hydrogen, coupled with the geocoronal emission foreground, seriously complicates the analysis of the Lyman-alpha spectra. The influence of the local interstellar medium on the observed profiles was circumvented by observing stars with radial velocities sufficiently high to Doppler shift the center of the stellar emission line out of the interstellar absorption core. There are several stars that have high radial velocities by virtue of their presence in close binary systems. High resolution IUE (International Ultraviolet Explorer) spectra of Ly alpha line of two such eclipsing binary stars, AR Lac and TY Pyx, are obtained, at each orbital quadrature phase, when the projected orbital velocity is a maximum. By combining the spectra from opposite quadratures it is possible to piece together the entire stellar emission profiles. The third star in this study, delta Lep, is a single star with a high space velocity. ESA

**N91-17921#** Hamburger Sternwarte G.m.b.H. (Germany, F.R.).
**SUPERGIANT CHROMOSPHERES AND COOL CORONAE AT THE TRANSITION FROM COOL TO HOT CIRCUMSTELLAR MATTER**
K.-P. Schroeder *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 345-347 Sponsored by Commission of the European Communities (For primary document see N91-17861 09-90)
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Chromospheric eclipses of 54 zeta Aurigae Systems (HR 6902, HR2554, tau Per and 22 Vul) are studied by means of 20 IUE (International Ultraviolet Explorer) high resolution spectra. Models

of eclipse geometry and chromospheric Fe II column density as a function of height are calculated by means of curves of growth. The primaries are situated in the narrow part of the HR diagram where circumstellar matter changes from hot to cool. The significant correlation between exact HRD location and chromospheric Fe II absorption suggests a temperature and ionization jump located closely left of the circumstellar (or Ca II K) dividing line. Cool neutral chromospheres here change into cool coronae as detected by extended C II and Si II absorption (HR6902 and HR2554).
ESA

**N91-17922*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
**THE LONG-TERM MONITORING OF THE SPECTROPHOTOMETRIC IUE STANDARD STARS**
M. R. Perez, N. Oliversen, M. Garhart, and T. Teays (Computer Sciences Corp., Greenbelt, MD.) *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 349-352 (For primary document see N91-17861 09-90)
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For more than twelve years the International Ultraviolet Explorer (IUE) satellite has consistently monitored about 44 spectrophotometric standard stars. This monitoring program was set up mostly to fit some particular needs of the IUE mission, such as the study of the detector linearity, sensitivity, degradation, and scattered light profiles. The impressive body of data accumulated over the years of about 7000 images, is unique and particularly suited for stellar studies on the stars themselves. The most frequently observed early type stars used as baseline calibration standards are studied. Part of what has been learnt about the cameras from studies of these spectral images and which has indirectly affected most of the published studies is presented. Possible improvements in flux accuracy which will be incorporated in the IUE final archives are discussed. ESA

**N91-17923#** Rutherford Appleton Lab., Chilton (England).
**ACCURATE DIFFERENTIAL PHOTOMETRY USING THE FINE ERROR SENSOR**
C. D. Pike and Willem Wamsteker (European Space Agency. ESA Tracking Station, Madrid, Spain ) *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 353-355 (For primary document see N91-17861 09-90)
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Accurate photometry of the star 29 Cygni was obtained with the Fine Error Sensor (FES) onboard IUE (International Ultraviolet Explorer). By using differential photometry, a photometric accuracy of 0.001 mag was achieved over a 7 hour observing period. The kind of photometric instabilities inherent in the FES are monitored by recording the counts received from guide stars during long exposures. In general, the variations are smooth and not a rapid function of time, which suggests that if their cause is detector wide instabilities then differential measures of two or more objects could be used to eliminate these variations and obtain photometry to a considerably higher accuracy than the canonical few hundredths of a magnitude obtained so far. ESA

**N91-17924#** Consiglio Nazionale delle Ricerche, Frascati (Italy). Ist. Astrofisica Spaziale.
**THE VV CEP STAR KQ PUPPIS**
R. Viotti, C. Rossi, A. Altamore, G. B. Baratta, M. Friedjung, and G. Muratorio (Observatoire de Marseille, France ) *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 359-362 (For primary document see N91-17861 09-90)
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The ultraviolet and optical spectra of the long period binary KQ Pup are described. The M supergiant spectrum dominates the visual IR energy distribution with overimposed prominent emission lines of H and of ionized metals (permitted and forbidden). Short of 4000 A a hot continuum emerges which is attributed to a 30,000 K source. Possible photospheric features of the hot source might be He I 3819 A and the broad Balmer lines, while the broad UV absorptions could be associated with accretion processes. The narrow Fe II emissions are formed in a part of the cool star wind heated by the hot secondary radiation. Fluorescent effects on the Fe III 1914 A line are discussed. Suggestions for future space and ground research are given. ESA

**N91-17925#** Oxford Univ. (England). Dept. of Theoretical Physics.
**THE ULTRAVIOLET SPECTRUM OF FG Sge**
Benjamin Montesinos, Angelo Cassatella, Rosario Gonzalez-Riestra, and Telmo Fernandez-Castro (Universidad Complutense, Madrid, Spain ) *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 363-366 (For primary document see N91-17861 09-90)
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The ultraviolet spectrum of FG Sge, a peculiar supergiant star which is the center of a planetary nebula, is analyzed. The origin of the spectral features and the shape of the continuum is studied. The strong effect of processes involving Fe II and Fe III on the observed spectral distribution is emphasized. Results of combined infrared and ultraviolet monitoring of FG Sge over the period 1982 to 1989 are summarized. ESA

**N91-17926*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
**ULTRAVIOLET LIGHT CURVES OF GALACTIC AND EXTRA-GALACTIC CLASSICAL CNO NOVAE: PW VUL, OS, AND LMC 1988 NO. 1 AND NO. 2**
S. Austin, Sumner G. Starrfield, P. Saizar (Ohio State Univ., Columbus.), Steven N. Shore, and George Sonneborn *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 367-370 (For primary document see N91-17861 09-90)
(Contract NAS5-28731; NAG5-481; NSF AST-88-18215; NSF AST-87-19607)
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In order to determine the comparative energy budgets of novae in outburst, the ultraviolet light curves for a number of novae are determined. The low dispersion IUE (International Ultraviolet Explorer) spectra of PW Vul 1984, OS And 1986, LMC 1988 number 1 and number 2 and obtained values for the integrated energy emitted in the wavelength interval from 1200 to 3400 A, not including the geocoronal Lyman-alpha emission line are re-examined. The light curves show that the brightness of the nova declines much more slowly in the ultraviolet than the optical, that the maximum brightness of the nova occurs much later in the ultraviolet than in the optical, and the peak luminosity is super Eddington for LMC 1988 number 2. ESA

**N91-17927#** Padua Univ. (Italy). Dept. of Astronomy.
**THE SPECTRAL ENERGY DISTRIBUTION OF STELLAR GENERATIONS: EVOLUTION AND COMPARISON WITH CLUSTER SPECTRA**
G. Barbaro and F. M. Olivi (International School for Advanced Studies, Trieste, Italy ) *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 371-374 (For primary document see N91-17861 09-90)
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The evolution of the spectral energy distribution in the UV and visible region of a stellar generation is modeled starting from evolutionary tracks and model atmospheres. The age spans an interval of 15 Gyr and different compositions are considered. The models are compared with the IUE (International Ultraviolet Explorer) spectra of young clusters of the large Magellanic cloud obtained by Cassatell, Barbero and Geyer (1987) and with the spectra of galactic globular clusters. ESA

**N91-17928#** Leicester Univ. (England). Dept. of Physics and Astronomy.
**STUDY OF CORONAL AND TRANSITION REGION STRUCTURE IN THE CONTACT BINARY 44i BOO THROUGH ROTATIONAL MODULATION OF THE FAR-UV SPECTRA**
M. A. Barstow, G. E. Bromage, and J. B. Holberg (Arizona Univ., Phoenix.) *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 375-378 Sponsored in part Science Research Council, England (For primary document see N91-17861 09-90)
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During April 1989, the W UMa type contact binary 44i Boo was observed by IUE (International Ultraviolet Explorer) for several binary periods using four contiguous shifts. A total of 26 low resolution SWP (Short Wavelength Prime) and 12 high resolution LWP (Long Wavelength Prime) spectra were obtained spanning 5 cycles. Large modulations in the intensities of the features found in the spectra were seen. As the various lines are formed at different temperatures, and therefore usually at different heights, in the transition region and corona, the results are used to study the morphology of the active regions in this system. ESA

**N91-17929#** Consiglio Nazionale delle Ricerche, Frascati (Italy). Ist. di Astrofisica.
**MULTIFREQUENCY BEHAVIOUR OF THE X RAY/Be SYSTEM A0535+26/HDE 245770 AT THE PERIASTRON PASSAGE IN MARCH - APRIL 1989**
F. Giovannelli, P. Persi, D. deMartino, C. Bartolini, A. Guarnieri, A. Piccioni, M. Teodorani, M. Burger, E. L. vanDessel, and V. G. Kurt (Academy of Sciences, USSR, Moscow ) et al *In* ESA, Evolution in Astrophysics: IUE Astronomy iin the Era of New Space Missions Aug. 1990 p 379-381 (For primary document see N91-17861 09-90)
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The results of a coordinated campaign devised to observe the Be x ray transient binary system A0535+26/HDE 245770 during its activity period in March to April 1989 at the periastron passage of the neutron star are presented. Multifrequency observations are carried out, ranging from x rays to near infrared domain. Despite large x ray activity (one of the most remarkable x ray flares was actually recorded), the IUE (International Ultraviolet Explorer) UV observations show a quiescent picture. Optical, infrared and polarization measurements show interesting features probably correlated with x ray activity. These data are discussed in the framework of a model of an accretion driven by a high density low velocity wind. ESA

**N91-17930*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
**GAS DYNAMICS, ACCRETION, AND EVOLUTION OF ALGOLS: INITIAL RESULTS FOR THREE REPRESENTATIVE SYSTEMS**
A. Gimenez, Rosario Gonzalez-Riestra, Edward F. Guinan, Yoji Kondo, G. McCluskey, D. H. Bradstreet, G. P. McCook, J. D. Dorren, S. Johansson, and J. Sahade (La Plata Univ., Argentina ) *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 383-386 (For primary document see N91-17861 09-90)
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IUE (International Ultraviolet Explorer) observations were made around the orbits of three Algol-type binaries: R Arae, U Cephei and Algol. These stars were selected to represent, respectively, the rapid, moderate and slow phases of mass transfer and mass loss in Algols. The data was obtained to derive maps of gas flow and mass loss, to study accretion processes and kinetic heating, and to investigate the importance of magnetic fields in these systems. Continuous observations were made from GSFC and VILSPA over 4 1/3 consecutive days during 10 to 14 Sep. 1989. A total of 100 spectra are obtained. This is the first time that Algol systems are observed continuously over their orbits with IUE. Initial results from this program are discussed. ESA

**N91-17931#** Helsinki Univ. of Technology, Espoo (Finland). Observatory and Astrophysics Lab.
**IUE OBSERVATIONS OF THE RS CVn-TYPE BINARY ALPHA2CrB**
D. Hannikainen, O. Vilhu, J. Huovelin, and R. A. Stern (Lockheed Aircraft Corp., Palo Alto, CA.) *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 387-391 (For primary document see N91-17861 09-90)
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An Alpha squared CrB, and RS CVn-type binary system consisting of two early G dwarfs is studied. The star is observed with the IUE (International Ultraviolet Explorer) during 28 to 29 June 1988. Eleven low resolution SWP (Short Wavelength Prime) and fifteen high resolution LWP (Long Wavelength Prime) spectra cover the entire orbital period. Measurements of fluxes versus phase are obtained from the SWP and wavelength and flux versus phase from the LWP. The flux values vary for the SWP spectra indicating flare activity (and possible rotational modulation) whereas the Mg II line fluxes from the LWP spectrum show no variation. Results of observations obtained partially simultaneously with the GINGA satellite and the IUE are shown. ESA

**N91-17932#** Eidgenoessische Technische Hochschule, Zurich (Switzerland). Inst. of Astronomy.
**RAYLEIGH SCATTERING IN SYMBIOTIC STARS**
M. Vogel *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 393-396 (For primary document see N91-17861 09-90)
(Grant SNSF-21-27448.89)
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It was recently proposed that Rayleigh scattering by atomic hydrogen may be responsible for eclipse effects in symbiotic systems. When looking through the IUE (International Ultraviolet Explorer) low resolution archive, this mechanism can indeed be identified in several objects. Rayleigh scattering allows the determination of several physical parameters of these binary systems: the velocity law and the mass loss rate of the cool giant can be inferred, the fraction of the ionized part of the cool wind, the inclination of the orbital plane, and the location of the emission line region. This is demonstrated in the case of EG And. ESA

**N91-17933*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
**PROPERTIES OF THE CENTRAL STAR OF NGC 6826 (03f)**
S. Heap, Bruce Altner, I. Hubeny, and B. Bohannan (Colorado Univ., Boulder.) *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 397-400 (For primary document see N91-17861 09-90)
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High dispersion ultraviolet and visual spectra are used to derive the properties of the O3laf-type central star of the planetary nebula, NGC 6826. It is concluded that the star has a temperature of 50,000 K and a mass of 0.65 M. Discrepancy is found between the mass derived from photospheric analysis and the mass derived from other methods. ESA

**N91-17934#** Technische Univ., Munich (Germany, F.R.).
**CORRELATED NEAR-PHOTOSPHERIC AND STELLAR-WIND VARIABILITY IN THE O SUPERGIANT LAMBDA CEP**
H. F. Henrichs, D. R. Gies, L. Kaper, R. Kudritzki, D. McDavid, B. Muschielok, Joy Y. Nichols-Bohlin, S. Voels, and G. Zwarthoed (Amsterdam Univ., Netherlands ) *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 401-405 Sponsored by NWO Constantijn en Christiaan Huygens Fellowship (For primary document see N91-17861 09-90)
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During three consecutive days in October 1989, 23 high resolution spectra of the O6 I (n) fp star lambda Cep, covering

the stellar wind lines C 4, Si 4 and Ni 5 were obtained. These observations are supported by more than 180 spectra obtained during 5 nights at the Calar Alto and Kitt Peak Observatories, covering He II 4686 and He II 4713. Additional photometry and polarimetry is carried out. The saturated C 4 edge velocity shows a gradual increase of about 10 percent in velocity (to about 2400 km/s) in the course of one day, which indicates a significant change in the supersonic part of the stellar wind. The beginning of this episode is marked by sudden, rather complex, changes near the line center of the double peaked He 2 emission. This emission line is thought to be formed close to the star, and is found to be variable at the shortest recorded timescale (about 15 min). The photospheric He I absorption line shows faint absorption features moving from blue to red, which are interpreted as being due to nonradial pulsation. The observed variability is interpreted as being due to a structural change in the stellar wind, triggered by some event close to the stellar surface. It is concluded that such covariability exists in many early-type stars. ESA

**N91-17935#** Oslo Univ. (Norway). Inst. of Theoretical Astrophysics.

**VARIABILITY AND VELOCITY FIELDS IN THE ALPHA ORI ATMOSPHERE**

P. Joraas *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 407-410 (For primary document see N91-17861 09-90)

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The red giant alpha Orionis (Betelgeuse) is known to exhibit both long term regular and short term irregular variations in the optical wavelength region. Observations with IUE (International Ultraviolet Explorer) during the past decade revealed significant variations in the UV emission lines as well. Flux and velocity variations on a time scale of 1 to 1.5 years were found in these lines. Phase differences between the variations of lines formed at different heights are seen. Recent optical observations revealed similar photospheric velocity variations with much smaller amplitude than seen in chromospheric lines. These observations strongly suggest the propagation of a wave with increasing amplitude through the outer atmosphere. The velocities seen in central reversals of strong resonance lines are correlated with the line centroid velocities, but are somewhat blueshifted, suggesting a positive velocity gradient. ESA

**N91-17936#** Amsterdam Univ. (Netherlands). Inst. of Astronomy.

**ORBITAL VARIABILITY IN THE UV SPECTRA ON THE MASSIVE X RAY BINARY HD153919/4U1700-37**

L. Kaper, G. Hammerschlag-Hensberge, and R. J. Takens *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 411-414 (For primary document see N91-17861 09-90)

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Variability of orbital phase in the IUE (International Ultraviolet Explorer) spectra of the optical counterpart HD153919 of the massive x ray binary 4U1700-37 is reported. In an interval of about 200 angstrom centered around the surbordinate line He II Alpha 1640 angstrom, emission lines 2 to 3 angstrom wide appear and disappear correlated with the binary phase. Raman scattering of extreme UV photons, emitted by the x ray source, through He II ions in the stellar wind of the O supergiant is suggested as the mechanism for the formation of these variable lines. ESA

**N91-17937*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.

**A STATISTICAL ANALYSIS OF IUE SPECTRA OF DWARF NOVAE AND NOVA-LIKE STARS**

Constanze laDous *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 415-417 (For primary document see N91-17861 09-90)

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First results of a statistical analysis of the IUE International Ultraviolet Explorer archive on dwarf novae and nova like stars are presented. The archive contains approximately 2000 low resolution spectra of somewhat over 100 dwarf novae and nova like stars. Many of these were looked at individually, but so far the collective information content of this set of data has not been explored. The first results of work are reported. ESA

**N91-17938#** European Space Agency. ESA Tracking Station, Madrid (Spain). IUE Observatory.

**UV ORBITAL VARIABILITY IN THE INTERMEDIATE POLAR H2215-086**

D. deMartino, M. Mouchet, and K. Mukai (California Univ., Berkeley.) *In its* Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 419-422 (For primary document see N91-17861 09-90)

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A search for UV orbital variations in the intermediate polar H2215-086 (FO Aqr) is presented. A large (approximately 40 percent) modulation with P sub orb equal to 4.85 h is found in the continuum, being as intense as in the optical. Orbital variations up to a factor of 2 in the equivalent widths of emission resonance lines of C4 and N5 are observed while He 2 (alpha 1640) emission behaves differently. The nature of the observed variability is discussed in terms of x ray reprocessing effects. ESA

**N91-17939#** Observatoire de Paris-Meudon (France).

**CATACLYSMIC VARIABLES WITH ANOMALOUS UV EMISSION LINE SPECTRUM**

M. Mouchet, J. M. Bonnet-Bidaud, J. M. Hameury, and A. Acker (Observatoire de Strasbourg, France ) *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 423-426 (For primary document see N91-17861 09-90)

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International Ultraviolet Explorer (IUE) observations of two magnetic cataclysmic variable systems, H0538 + 608 and H0542-407 reveal largely different emission line spectra (high NV/CIV ratio) compared to other objects of this class. Repeated IUE observations of H0538+608 show that these characteristics are always present. Several features in the UV and optical spectra of H0538+608 tend to favor an explanation in terms of non-solar abundances. A possibility is that the external layers of the comparison have been stripped off, revealing the chemical composition of the core. ESA

**N91-17940#** Rutherford Appleton Lab., Chilton (England). Astrophysics Div.

**ULTRAVIOLET CONTINUUM IN SOLAR AND dMe STAR FLARES**

K. J. H. Phillips, G. E. Bromage, and J. G. Doyle (Armagh Observatory, Ireland ) *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 427-429 (For primary document see N91-17861 09-90)

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The strong continuum seen in the International Ultraviolet Explorer (IUE) short wavelength range during large flares on dMe stars is proposed to be due, like that in the Sun, to Si recombination radiation arising from ionization of neutral silicon in the temperature minimum by intense ultraviolet lines. The evidence is twofold: (1) the ultraviolet line intensity is highly correlated with the continuum intensity; and (2) the Si I recombination edge at 1520 angstroms is possibly present in some spectra. The same correlation appears to hold for a large flare seen on II Peg, an RS CVn star. ESA

**N91-17941*#** Harvard-Smithsonian Center for Astrophysics, Cambridge, MA.

**LONG AND SHORT TIMESCALE VARIABILITY OF MAGNETIC ACTIVITY ON THE BY DRA STAR BD+26 DEG 730**

S. H. Saar, L. Golub, B. Bopp, W. Herbst, and J. Huovelin (Helsinki

Univ. of Technology, Espoo, Finland ) *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 431-434 Sponsored in part by Aaltonen Foundation (For primary document see N91-17861 09-90)
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BD+26 degree 730 is a very active K5V flare star with a 60 year starspot cycle. Since it is also nearly pole-on, it presents an unusual opportunity to study purely temporal evolution of magnetic activity. Contemporaneous International Ultraviolet Explorer (IUE), magnetic flux, polarimetric, and H alpha observations of the star taken over several rotational periods in 1988 are presented. When combined with older photometry, optical and IUE archive spectra, the data show a surprising lack of any activity variability on either short (few days) or long (years) timescales. The lack of variability is suggested to be due to a nearly saturated level of magnetic activity on the star, as indicated by its large magnetic filling factor. ESA

**N91-17942*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
**PW VUL: A CLASSICAL NOVA WITH NEARLY SOLAR ABUNDANCES**
P. Saizar, Sumner G. Starrfield, S. Austin, G. J. Ferland, R. M. Wagner, J. W. Truran, George Sonneborn, S. J. Kenyon, W. M. Sparks, and R. E. Williams (Cerro Tololo Inter-American Observatory, La Serena, Chile ) et al *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 435-438 Previously announced as N90-29275 (For primary document see N91-17861 09-90)
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Ultraviolet and optical spectrophotometric data are combined in order to determine the physical parameters in the expanding shell of Nova PW Vul 1984. Ultraviolet data obtained with the International Ultraviolet Explorer (IUE) satellite from August 2, 1984 (a few days after discovery) until it became too faint to study with the satellite is presented. The last IUE exposure was obtained in June 1988 but it was continually followed with ground based optical telescopes. A plot showing the variation of electron density and temperature as a function of time is presented. Analysis of the emission line intensities show that the abundances of this very slow nova are solar for helium, carbon, and oxygen while nitrogen is 50 times solar. The CLOUDY code of Ferland is used to model the emission line intensities and find good agreement with the observations. Plots representative of IUE and optical spectra are displayed. ESA

**N91-17943*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
**NOVA LMC 1990 NO. 1: THE FIRST EXTRAGALACTIC NEON NOVA**
George Sonneborn, Steven N. Shore, and Sumner G. Starrfield (Arizona State Univ., Tempe.) *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 439-442 Previously announced as N90-29276 Sponsored in part by DOE (For primary document see N91-17861 09-90)
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International Ultraviolet Explorer (IUE) observations of nova LMC (Large Magellanic Cloud) 1990 No. 1, the first neon (or ONeMg) nova observed outside the Galaxy are presented. The observations were obtained from 17 Jan. to Mar. 1990, with especially dense coverage during the first 25 days of the outburst. (The neon nova categorization is based on the detection of forbidden Ne 3-4 lines in optical spectra; the ultraviolet neon lines were not detected.) During the first 30 days of the outburst, the radiative losses were dominated by the N 5 delta 1240 and C 4 delta 1550 lines. The maximum ejection velocity was approximately 8000 km/s, based on the blue absorption edge of the C 4 P-Cygni profile. Early in the outburst of Nova LMC 1990 No. 1 the UV luminosity alone was approximately 3 times 10 to the 38th power erg/sec, implying that the bolometric luminosity was well in excess of the Eddington luminosity for a one solar mass object. ESA

**N91-17944*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
**NOVA LMC 1990 NO. 2: THE FIRST EXTRAGALACTIC RECURRENT NOVA**
Steven N. Shore, George Sonneborn, Sumner G. Starrfield, R. E. Williams, Angelo Cassatella, and H. Drechsel (Remeis Sternwarte, Bamberg, Germany, F.R. ) *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 443-446 (For primary document see N91-17861 09-90)
(Grants NAG5-481; NSF AST-88-18215)
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International Ultraviolet Explorer (IUE) observations of Nova LMC (Large Magellanic Cloud) 1990 number 2 are presented. It is the first recurrent nova to be observed outside the Galaxy. Earlier optical outburst of the nova was observed in 1968, when it reached a maximum of about V = 10.2. The first observations caught the nova at UV maximum, and IUE spectra were obtained between 16 Feb. and 26 Mar. 1990, with 8 hour resolution during the first day of observations. No P Cyg profiles developed on the resonance lines, suggesting that very little mass was ejected and that the outburst was not spherical. The integrated UV luminosity was then 3.4 x 10(exp 38) erg/s which is above the Eddington limit for a one solar mass white dwarf (assuming E (B - V) = 0.15 and a distance of 55 kpc to the LMC). This is the first time that the luminosity of a recurrent nova has been directly obtained. ESA

**N91-17945*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
**IUE OBSERVATIONS OF GALACTIC AND EXTRAGALACTIC RECURRENT NOVAE**
Steven N. Shore, George Sonneborn, and Sumner G. Starrfield (Arizona State Univ., Tempe.) *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 447-450 (For primary document see N91-17861 09-90)
(Grants NAG5-481; NSF AST-88-18215)
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A collection of International Ultraviolet Explorer (IUE) light curves and sample spectra for the galactic recurrent novae observed in the ultraviolet are presented. These data are compared to that of the Nova LMC (Large Magellanic Cloud) 1990 number 2 which is shown to also be a recurrent novae. Based on the analysis of the outburst of N LMC 1990 number 2 it is suggested that all of the recurrent novae observed in the ultraviolet have luminosities at maximum light which exceed the Eddington limit. V745 Sco and RS Oph, the two recurrent novae with late type giant companions, show strong Mg II throughout the outburst. Those with low luminosity companions, U Sco and V394 CrA do not show Mg II but do show strong He II 1640 earlier in the outburst. Typical emission line velocities are greater than those observed in many of the classical novae. These characteristics suggest that the white dwarfs in recurrent novae systems are close to the Chandrasekhar limit. ESA

**N91-17946*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
**LATE STAGES IN THE EVOLUTION OF CLASSICAL NOVAE**
Sumner G. Starrfield, J. Krautter, George Sonneborn, Steven N. Shore, R. M. Wagner, S. Austin, P. Saizar, G. J. Ferland, R. Wade, and R. D. Gerhz (Minnesota Univ., Minneapolis.) et al *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 451-455 Sponsored in part by DOE (For primary document see N91-17861 09-90)
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The long term evolution of novae in outburst is studied in order to determine the means by which they return to quiescence when nuclear burning has ended is described. The project involves both International Ultraviolet Explorer (IUE) and optical observations and theoretical predictions. In the initial observational part of this project, IUE SWP (Short Wavelength Prime) spectra of GQ Mus 1983 and QU Vul 1984 are obtained. Each spectrum was a 16 hour exposure using a combined US1 plus Vilspa shift. No novae were sudied in the UV for as long as QU Vul and GQ Mus and observations of their spectral evolution provides unique data on the turnoff time scale. The spectra of old novae from the IUE archives are used to compare the existing spectra with those of GQ Mus and QU Vul. The theoretical prediction is that a nova should be very hot just before turnoff but x ray observations from EXOSAT do not confirm this prediction. ESA

**N91-17947#** Tuebingen Univ. (Germany, F.R.). Inst. fuer Astronomie.

**THE 1987 OUTBURST OF THE RECURRENT NOVA V394 CORONAE AUSTRINAE**

M. A. J. Snijders, K. Sekiguchi, and Angelo Cassatella (European Space Agency. European Space Research and Technology Center, ESTEC, Noordwijk, Netherlands ) *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 457-460 (For primary document see N91-17861 09-90)

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Optical and ultraviolet observations of the recurrent nova V394 CrA are presented. At day 20, the density in the ejecta is log (Ne) = 9.8 +/- 0.4 and the temperature varies from 10,000K to 14,000K. The abundances varies from 10,000 K to 14,000K. The abundances in the ejecta are virtually the same as those for classical C/O novae. The total shell mass is 2E-8 Mo. Low resolution International Ultraviolet Explorer (IUE) spectra are extracted from the IUESIPS line by line files. Image defects are, if possible, removed or the affected regions are flagged and ignored. As most emission lines have a broad profile with a flat top, the strong interstellar absorption lines are used as wavelength standards for all IUE spectra. ESA

**N91-17948*#** Heidelberg Univ. (Germany, F.R.). Inst. fuer Theoretische Astrophysik.

**MODEL ATMOSPHERES FOR THE EARLY STAGES OF NOVAE IN OUTBURST**

R. Wehrse, P. H. Hauschildt, G. Shaviv, and Sumner G. Starrfield (California Univ., La Jolla.) *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 461-466 Sponsored in part by DOE (For primary document see N91-17861 09-90)

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For the photospheres of classical novae during the early stages of their outbursts, continuum and line blanketed models are presented. The expanding envelopes are characterized by small density gradients that lead to very large geometrical extensions and large temperature differences between inner and outer parts. The spectra show large excesses in the IR and small Balmer jumps which may either be in absorption or emission. For the parameters considered most lines are in absorption if powerlaw density distributions and radiative equilibrium are assumed. The effects of modifications in the temperature structure (e.g., heating from shock fronts) and in the density stratifications as well as changes in the abundances are discussed. ESA

**N91-17949*#** Villanova Univ., PA.

**THE CI PRESSURE SHIFT AND GRAVITATIONAL REDSHIFT OF THE COOL DBQA5 WHITE DWARF LDS678A**

E. M. Sion, G. Vauclair, T. D. Oswalt, G. Hammond, J. Liebert, D. Koester, G. Wegner, and P. Marcum (Iowa State Univ. of Science and Technology, Ames.) *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 467-470 (For primary document see N91-17861 09-90)

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A high resolution ultraviolet spectrum of the helium rich degenerate LDS 678A, obtained with the International Ultraviolet Explorer (IUE) satellite is presented. LDS 678A is the coolest metallic line generate (DQ or DZ) yet observed with the IUE scale. These observations provide a detailed line profile of the strong C I 2479 absorption line with equivalent width (W sub 2479 = 2.35 plus or minus 0.06 angstroms) from which theoretical line profile fits yield a C abundance (log C/He = 6.4). The presence of carbon in a helium rich atmosphere lends credence to the notion that LDS 678A is a transitional case between the DB white dwarfs with nearly pure helium atmospheres and the helium rich DQ white dwarfs which exhibit carbon bands. Corrected for an inferred pressure shift for the C I line, a gravitational redshift is deduced from which a most probable mass of 0.55 solar mass is derived. ESA

**N91-17950*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.

**ULTRAVIOLET, VISUAL, AND INFRARED STUDIES OF GALACTIC EXTREME EMISSION LINE OBJECTS WITH VERY LARGE IR-EXCESS**

D. deWinter, M. R. Perez, J. Y. Hu, and P. S. The (Amsterdam Univ., Netherlands ) *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 471-474 (For primary document see N91-17861 09-90)

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Some preliminary results of a study of extreme emission line objects (EELOs) are presented. These stars are selected from H alpha emission line stars having a strong IR excess. The study is based on multiwavelength photometric and spectroscopic observations. Special attention is paid to the detailed study of the correlation between spectroscopic and photometric variations, which indicate the activity of the star. The ultraviolet and infrared extinction characteristics of the circumstellar material are given special attention. ESA

**N91-17951#** Rutherford Appleton Lab., Chilton (England).

**HYDRODYNAMIC MODELLING OF Be-BINARIES AND ITS APPLICATIONS**

D. Wonnacott *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 475-476 (For primary document see N91-17861 09-90)

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The properties of some B type emission line stars are believed to be due to the presence of a matter stream in those systems. UV observations with the International Ultraviolet Explorer (IUE) confirm this. In order to obtain more reliable information concerning these objects, synthesis of the UV resonance lines is undertaken using hydrodynamic models to provide the density and velocity information needed to generate line profiles. Profile fitting yields information on the inclination of the system and on the abundances of the transferred material. Results for CX Draconis (HD174237, B2.5Ve+F?) show that iota is approximately equal to or greater than 35 degrees and that the matter stream probably consists of material which has been heavily CNO processed. ESA

**N91-17952*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.

**ULTRAVIOLET OBSERVATIONS OF X RAY TRANSIENTS**

Chris R. Shrader *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 477-478 (For primary document see N91-17861 09-90)

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Preliminary results of new International Ultraviolet Explorer (IUE) observations of two major transient events, the April 1989 outburst of the Be star transient system A0535+26 and the remarkable May/June 1989 outburst of V404 Cygni, are discussed. The UV data for V404 Cygni, combined with contemporaneous published optical and x ray data are not satisfactorily represented by standard accretions disk models. ESA

**N91-17953*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
**NARROW CIRCUMSTELLAR EMISSION LINES IN SN 1987A**
George Sonneborn, Angelo Cassatella, Willem Wamsteker, Claes Fransson, Robert Kirshner, Roberto Gilmozzi, and Nino Panagia (Space Telescope Science Inst., Baltimore, MD.) *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 479-481 (For primary document see N91-17861 09-90)
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Low and high dispersion short wavelength prime (SWP) spectra of SN 1987A show that the supernova's progenitor was in a post red giant branch stage of evolution at the time of its demise in February 1987. The development of narrow high temperature emission lines of N 5, N 4, N 3, C 3, He 2 and O 3 were followed since May 1987. Observations through April 1990 are presented. The lines are interpreted as arising in a low density gas surrounding the supernova which was photoionized by the extreme UV pulse at shock breakout. In this picture, their temporal evolution is determined primarily by light travel time effects and recombination. Comparison of models of circumstellar environment with the International Ultraviolet Explorer (IUE) observations are discussed. ESA

**N91-17954#** European Southern Observatory, Garching (Germany, F.R.).
**IMPROVED MONTE CARLO MODELS FOR THE EARLY TIME SPECTRUM OF SN 1987A**
Paolo A. Mazzali and L. B. Lucy *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 483-486 (For primary document see N91-17861 09-90)
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A Monte Carlo simulation is employed to model the early time spectrum of SN 1987A. With respect to previous work, metal abundances more appropriate for the large Magellanic cloud are used, and special care is given to the treatment of ionization and excitation. In particular, it is found that strong line blocking in the UV, mostly due to the Mg II resonance doublet at 2800 angstrom and to Fe II lines, reduces the photoionization rate from excited levels and the photoexcitation rates from ground states. With the introduction of improvements, the model spectra agree well with the UV and optical observations. ESA

**N91-17955#** Queens Univ., Belfast (Northern Ireland).
**IUE, OPTICAL AND RADIO OBSERVATIONS OF HIGH VELOCITY GAS COMPONENTS IN THE NEARBY INTERSTELLAR MEDIUM**
S. Gilheany, B. Bates, M. G. Catney, F. P. Keenan, and R. D. Davies (Nuffield Radio Astronomy Labs., Jodrell Bank, England ) *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 489-493 Sponsored by Science Research Council, England and and DENI (For primary document see N91-17861 09-90)
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Following the discovery from International Ultraviolet Explorer (IUE) spectra of high velocity gas components in the nearby interstellar medium, research is carried out using new 21 cm H I observations and complementary optical data of the Na D lines. Further information on the morphology and velocity of the high velocity gas in the general direction towards the star 4 Lac is presented. It is concluded that better exposed IUE spectra are required in order to examine the fine structure C II and Si II levels which would give more accurate information on the electron temperature and density within the clouds. ESA

**N91-17956#** Stazione Astronomica Internazionale di Latitudine, Cagliari (Italy).
**DIFFUSE ABSORPTION BANDS IN ORION: A CORRELATION WITH THE UV REDDENING CURVE**
I. Porceddu and Piero Benvenuti (European Southern Observatory, Garching, Germany, F.R. ) *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 495-499 (For primary document see N91-17861 09-90)
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The known anomalous extinction curve in the UV spectral range in the direction of the Orion nebula is related to the strength of the two diffuse interstellar absorption bands 5780-5797 angstrom in the spectra of theta to the power of 1 ori D and NU Ori. The spectra presented are based on observations collected at the European Southern Observatory, La Silla, Chile, during two different observing runs. ESA

**N91-17957*#** Computer Sciences Corp., Greenbelt, MD. GHRS Science Team.
**THE HELIUM STRONG STARS OF THE ORI OB1 ASSOCIATION**
Steven N. Shore (Observatoire de Paris-Meudon, France ) *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 501-503 Sponsored in part by NASA, Goddard Space Flight Center (For primary document see N91-17861 09-90)
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International Ultraviolet Explorer (IUE) fluxes for the helium strong stars of the orion OB1b association and the physical parameters implied by these data are discussed. The helium strong stars are found to be main sequence, or only slightly evolved, stars between about 7 and 12 solar mass. ESA

**N91-17958*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
**GALACTIC SURVEY OF INTERSTELLAR ABUNDANCES AND SELECTIVE EXTINCTION WITH IUE AND IRAS**
Michael E. VanSteenberg and J. Michael Shull (Colorado Univ., Boulder.) *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 505-508 Sponsored in part by National Academy of Sciences-National Research Council (For primary document see N91-17861 09-90)
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A progress report on the results of a survey of UV selective extinction curves using the International Ultraviolet Explorer (IUE) satellite is presented. From IUE high resolution spectra, UV selective extinction curves are derived. These are fitted to six parameters characterizing the grey extinction, the 2175 angstrom bump, and the far ultraviolet curvature. These parameters are compared to the results of previous surveys of interstellar metals and infrared Cirrus intensities. With IUE high resolution spectra, equivalent widths of 18 ultraviolet resonance transitions toward 273 early type stars are measured and column densities are derived. Using the Infrared Astronomy Satellite (IRAS) all sky survey, infrared Cirrus intensities at 12, 25, 60, and 100 microns are measured. ESA

**N91-17959#** Lick Observatory, Santa Cruz, CA.
**AN ESTIMATION OF TEMPERATURES OF H I ZONE IN BLR OF SEYFERT 1 GALAXY I ZW1**
F. H. Cheng, J. H. You, and T. G. Wang (China Scientific and Technical Univ., Hofei.) *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 509-511 Sponsored By Chinese National Natural Science

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It is suggested that the small blueshift of high ionization lines with respect to low ionization or H I emission lines in quasars and active galactic nuclei can be explained by the Cerenkov line emission theory. The high ionization emission lines are generated by collisional excitation, but low ionization and H I emission lines are mainly generated by the Cerenkov line emission mechanism. Therefore, the latter have a small Cerenkov redshift added. Applying the theory to Seyfert 1 galaxy I ZW1, the temperatures of H I zone of the clouds in broad line region are estimated at approximately 9000 to 11,000K. ESA

**N91-17960#** European Southern Observatory, Garching (Germany, F.R.).
**PKS2152-69: A MISDIRECTED BLAZAR**
R. A. E. Fosbury, S. diSeregoAlighieri, T. J.-L. Courvoisier, M. A. J. Snijders, C. N. Tadhunter, J. Walsh, and W. Wilson (Commonwealth Scientific and Industrial Research Organization, Epping, Australia ) *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 513-516 (For primary document see N91-17861 09-90)
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PKS2152-69 is a bright, nearby radio galaxy with detached, nuclear like activity some 8 kpc from the nucleus along the radio axis. This highly ionized cloud contains a source of continuum radiation which, in the optical band, has a very blue spectrum and is 12 percent linearly polarized in the band. Following a suggestion that this continuum is scattered radiation from a Blazar beam, the cloud is observed in both the long and short wavelength regions with International Ultraviolet Explorer (IUE). A detection in the long wavelength and an upper limit in the short wavelength show that the energy distribution turns over at around 10 (exp 15) Hz giving a spectrum which can be fitted by scattering from dust particles smaller than those generally found in our local interstellar medium. For the beam power of a typical Blazar or BL Lac object, the mass of dust required is modest. New radio maps made with the Australia Telescope give evidence for a jet pointing in the direction of the cloud and show larger scale lobes in a significantly different position angle. ESA

**N91-17961#** Space Telescope Science Inst., Baltimore, MD.
**THE ULTRAVIOLET ATLAS OF QUASAR AND BLAZAR SPECTRA**
A. L. Kinney, R. C. Bohlin, J. C. Blades, and D. G. York (Chicago Univ., IL.) *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 517-521 (For primary document see N91-17861 09-90)
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An ultraviolet atlas of 69 quasars, blazars, and Seyfert 1 galaxies is constructed by combining over 1000 low resolution spectra drawn from over a decade of observations contained in the International Ultraviolet Explorer (IUE) data archive. Five quasars and three blazars were observed more than thirty times in both the short and the long wavelength cameras with IUE. These observations, which make up one of the best existing data sets for studying wavelength dependance of the variability and for comparing UV variability with optical variability, are discussed. The ultraviolet spectra in the Atlas are the highest signals to noise ultraviolet spectra available. The absence of Lyman edges, which offer constraints for the models of thermally emitting accretion disks and models of the geometry of the broad line region, and a number of absorption phenomena seen in the spectra, are discussed. ESA

**N91-17962*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
**THE MISSING UV ABSORPTION LINES OF NGC 4151**
K. J. Leech, M. V. Penston, M. A. J. Snijders, M. J. Ward (Royal Greenwich Observatory, Cambridge, England ), and T. R. Gull *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 523-525 (For primary document see N91-17861 09-90)
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Near simultaneous high dispersion long and short wavelength International Ultraviolet Explorer (IUE) observations of the Seyfert galaxy NGC 4151 are discussed. Previous observations revealed a narrow absorption system in Mg II not present in Ly alpha or C IV. The new observations confirm the presence of this system in Mg II and its absence in the other lines. Possible reasons for this are discussed. Future Hubble Space Telescope studies of NGC 4151 are discussed. ESA

**N91-17963*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
**C IV: LINE PROFILE CORRELATIONS IN NGC 4151**
A. G. Michalitsianos, R. P. Fahey, and D. M. Kazanas *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 527-530 (For primary document see N91-17861 09-90)
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Relative flux changes of the narrow emission lines that form the double-peaked structure of the C 4 line in NGC 4151 suggest two distinct regions of line formation. Correlations independent of model assumptions show the response to variations of the red and blue peak intensities to the total C 4 flux are significantly different. The dependence of the red peak intensity relative to the total C 4 flux, defined as the flux in a specified wavelength range lambda lambda 1520-1580, suggests this component is formed in an extended photoionized region. The blue component appears more directly dependent on variations of the total C 4 flux, which may indicate a close association with nuclear outflow. Possible implications for broad line region models are discussed. ESA

**N91-17964#** University Coll., London (England). Dept. of Physics and Astronomy.
**THE ULTRAVIOLET VARIABILITY OF 4C37.43 (QSO 1512+37)**
P. T. OBrien and P. M. Gondhalekar *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 531-534 (For primary document see N91-17861 09-90)
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A short campaign to monitor the quasar 4C37.43 with International Ultraviolet Explorer (IUE) is performed. This data combined with archive data is used to confirm an earlier report of low level emission line variability in this high luminosity active galactic nuclei (AGN). The observed variations in the line intensities and profiles are briefly compared to those seen in other AGN. ESA

**N91-17965*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
**IUE AND EINSTEIN OBSERVATIONS OF THE LINER GALAXY NGC 4579**
G. A. Reichert, E. M. Puchnarewicz, and K. O. Mason (Mullard Space Science Lab., Dorking, England ) *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 535-537 (For primary document see N91-17861 09-90)
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Results of International Ultraviolet Explorer (IUE) and Einstein observations of the LINER galaxy NGC 4579 are reported. Spatial profiles of the long wavelength IUE emission show a two component structure, with an unresolved core superimposed on broader underlying emission. The core spectrum shows strong C II lambda 2326 and broad Mg II lambda 2800 emission, and perhaps emission due to blends of Fe II multiplets (2300 to 23600 angstrom). The short wavelength emission is spatially unresolved, and shows

C II lambda 1335, C III lambda 1909 broad C IV lambda 1550 emission, and a broad feature at approximately 1360 angstrom which may be due to 0.1 lambda 1356. Contrary to previous reports no evidence for He II lambda 1640 is found in the spectrum. An unresolved x ray source is detected at the location of the nucleus; its spectrum is well fitted by a power law of energy slope alpha approximately -0.5. These results further support the idea that NGC 4579 may contain a dwarf Seyfert nucleus. ESA

**N91-17966#** Universidad Complutense, Madrid (Spain). Inst. de Astronomia.

**MULTIWAVELENGTH MONITORING OF THE SEYFERT 1 GALAXY NGC 4593**

M. Santos-Lleo, J. Clavel, P. Barr, and I. S. Glass (South African Astronomical Observatory, Cape Town.) *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 539-543 (For primary document see N91-17861 09-90)

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The Seyfert 1 galaxy NGC 4593 may be one of the rare examples where the big bump is absent or too weak and one is seeing the bare synchrotron tail of the radio source in the optical and ultraviolet. The results of an extensive multiwavelength monitoring of NGC 4593 are presented. The properties of the nuclear energy distribution over a broad energy range and the relationship between the emission process at different frequencies are described. The temporal behavior of the emission lines and the constraints which their variability impose on models of the broad line region are outlined. ESA

**N91-17967#** Ruhr Univ., Bochum (Germany, F.R.). Astronomical Inst.

**UV-X RAY RELATIONS AND THE BALDWIN EFFECT**

Hartmut Schulz *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 545-548 (For primary document see N91-17861 09-90)

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Mean UV x ray slopes of a Seyfert and a QSO sample are compared with the corresponding C IV lambda 1550/Lyman alpha, C IV lambda 1550/C III lambda 1909 intensity ratios and a grid of single component broad line models. The observed C IV/Ly alpha decrease with luminosity appears to be equivalent to the Baldwin effect and to be fully accounted for by the luminosity dependent ionizing continuum slope. Compared with Seyfert galaxies, QSOs are known to be x ray weak relative to the optical or UV spectral range. The shape of the ionizing continuum is luminosity dependent. The question of whether the continuum slope difference between QSOs and Seyferts could contribute to the Baldwin effect is discussed. ESA

**N91-17968#** Indian Inst. of Science, Bangalore. Dept. of Physics.

**ORIENTATION EFFECTS IN THE X RAY EMISSION FROM RADIO-LOUD QUASARS**

Prajval Shastri *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 549-551 (For primary document see N91-17861 09-90)

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The spectral indices of the x ray emission from radio-loud quasars are investigated. The spectral indices show that the soft x ray spectrum is flatter for core dominated quasars than for lobe dominated ones. Within the framework of the unified interpretation for radio quasars, the results support the suggestion that a component of the x ray emission is relativistically beamed. It is suggested that the putative x ray component associated with the radio emission, has a relatively flatter enhancement when the quasar jet is directed close to the line of sight. ESA

**N91-17969#** Indian Inst. of Science, Bangalore.

**ORIENTATION EFFECTS IN THE OPTICAL-ULTRAVIOLET EMISSION FROM RADIO QUASARS**

Prajval Shastri and V. K. Kapahi (Tata Inst. of Fundamental Research, Pune, India ) *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 553-555 (For primary document see N91-17861 09-90)

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If bulk relativistic motion is ubiquitous in the nuclear regions of radio-loud quasars, then core dominated quasars can be interpreted as lobe dominated quasars viewed end on. Observed differences between them are then due to orientation effects alone. Analyses of data on the host galaxies of quasars, and the optical magnitudes for the B2 sample of quasars are used to support the proposition that at least a component of the optical ultraviolet emission is aspect dependent. A comparison of the prominence of the radio cores for the 3CR and B2 quasars suggests that the aspect dependence arises due to relativistic beaming and due to disk inclination or obscuration effects. ESA

**N91-17970*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.

**OPTICAL, NEAR, INFRARED AND ULTRAVIOLET MONITORING OF THE SEYFERT 1 GALAXY MARKARIAN 335**

Chris R. Shrader, W.-H. Sun (National Central Univ., Chung-Li, Taiwan ), T. J. Turner, and P. M. Hintzen *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 557-559 (For primary document see N91-17861 09-90)

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Preliminary results of a multifrequency monitoring campaign for the bright, Seyfert 1 galactic nuclei Mkn335 are presented. Nearly uniform sampling at 3 day intervals is achieved quasi simultaneously at each wavelength band. Wavelength dependent variability is seen at the 20 to 30 percent level. Interpretation of variability in terms of geometrically thin, optically thick accretion disk models is discussed. The inferred blackhole masses and accretion rates are discussed. Possible correlation between continuum and emission line variations is discussed. ESA

**N91-17971*#** Space Telescope Science Inst., Baltimore, MD.

**ACCRETION DISK EMISSION FROM A BL LACERTAE OBJECT**

C. Megan Urry and Amri Wandel (Stanford Univ., CA.) *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 561-564 Sponsored by NASA, Washington (For primary document see N91-17861 09-90)

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The accretion disk is an attractive model for BL Lac objects because of its preferred axis and high efficiency. While the smooth continuum spectra of BL Lacs do not show large UV bumps, in marked contrast to quasars, high quality simultaneous data do reveal deviations from smoothness. Using detailed calculations of cool accretion disk spectra, the best measured ultraviolet and soft x ray spectra of the BL Lac object PKS 2155-304 are fitted. The mass and accretion rate required are determined. A hot disk or corona could comptonize soft photons from the cool disk and produce the observed power law spectrum in the 1 to 10 keV range. The dynamic time scales in the disk regions that contribute most of the observed ultraviolet and soft x ray photons are consistent with the respective time scales for intensity variations. The mass derived from fitting the continuum spectrum is consistent with the limit derived from the fastest hard x ray variability. ESA

**N91-17972#** European Space Agency. ESA Tracking Station, Madrid (Spain). IUE Observatory.

**MAPPING THE BLR: LINE VARIABILITY IN FAIRALL-9**

Willem Wamsteker, M. C. Recondo-Gonzalez, F. Cheng (China Scientific and Technical Univ., Hofei.), and J. Clavel *In its* Evolution in Astrophysics: IUE Astronomy in the Era of New Space

Missions Aug. 1990 p 565-569 (For primary document see N91-17861 09-90)
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A line decomposition of the Ly alpha lambda 1216 and C 4 lambda 1550 lines based on a previous study of H beta for the high luminosity Seyfert 1 galaxy Fairall-9 is presented. The line variability is used to support and contain the Gaussian decomposition. The lines show a well identified component structure which is valid for both Ly alpha lambda 1216 and C 4 lambda 1500. The components respond very differently to the changes in the ionizing continuum brightness. Hysteresis behavior is only seen for the central component, while the red component is strictly proportional to the continuum brightness. ESA

**N91-17973#** Alabama Univ., Tuscaloosa. Dept. of Physics and Astronomy.
**OPTICAL AND UV EMISSION LINE PROFILE IN 3C390.3**
Wei Zheng *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 571-572 (For primary document see N91-17861 09-90)
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The Ly alpha and H alpha line profiles of 3C390.3 in two different epochs are studied. The broad UV and optical emission lines have similar profiles and show coordinated profile changes near the core and the blue wing during a reversal of profile between 1979 an 1980. If the very broad lines arise in a disk geometry, the clouds should emit both low and high ionization lines. A large number of International Ultraviolet Explorer (IUE) spectra are available for the study of the objects of Ly alpha emission. The object is broadly variable and hence makes careful comparisons difficult because most multiband data were not obtained simultaneously. It is noted, however, that although the line flux level changes frequently, the shape of broad lines remains stable over the period of several years. ESA

**N91-17974#** Tuebingen Univ. (Germany, F.R.). Inst. fuer Astronomie.
**SCIENTIFIC HIGHLIGHTS OF THE ORFEUS 1M-EUV/FUV-TELESCOPE**
N. Kappelmann, J. Barnstedt, N. Eberhard, M. Grewing, W. Gringel, C. Haas, A. Kaelble, G. Kraemer, J. Petrik, and I. Appenzeller (Landessternwarte auf dem Koenigstuhl, Heidelberg, Germany, F.R.) et al *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 573-576 (For primary document see N91-17861 09-90)
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The Orbiting and Retrieval Far and Extreme Ultraviolet Spectrometer (ORFEUS), a 1 m normal incidence telescope for spectroscopic investigations of cosmic sources in the far and extreme ultraviolet spectral range is described. The telescope is equipped with two spectrometers operated alternatively: a modified Rowland spectrometer, allowing moderate resolution spectroscopy in the range from 40 to 120 nm and an Echelle spectrograph for high resolution spectroscopy in the 190 to 125 nm range. The capabilities of the ORFEUS instrumentation are discussed with different classes of objects and a preliminary target list is shown. ESA

**N91-17975*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
**UV PROPERTIES OF HOT STARS IN NGC 6752**
Bruce Altner (Computer Sciences Corp., Greenbelt, MD.) *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 579-582 (For primary document see N91-17861 09-90)
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The UV properties of hot stars found in the center of NGC 6752 are compared with those outside the core. Few, if any, faint sdB stars are found in the central region, whereas they occur in significant numbers far from the core. A statistically complete photographic survey is used to demonstrate that the faint blue stars in NGC 6752 occur in greater numbers with increasing distance form the center, and the International Ultraviolet Explorer (IUE) findings extend this result all the way to the center of the cluster. A similar phenomenon has been observed optically in other clusters, such as M15. ESA

**N91-17976#** Padua Univ. (Italy). Departimento di Astronomia.
**RECENT IUE OBSERVATIONS OF EARLY-TYPE GALAXIES**
F. Bertola, L. M. Buson, and D. Burstein (Arizona State Univ., Tempe.) *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 583-585 (For primary document see N91-17861 09-90)
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The International Ultraviolet Explorer (IUE) observations of the ultraviolet spectral energy of early type galaxies are summarized. Galaxies newly observed include M32, NGC 4111, NGC 185, NGC 1052, NGC 1399 and M87. In all cases, the observations add significant additional information about the far UV behavior of these galaxies. ESA

**N91-17977*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
**MULTIWAVELENGTH STUDIES OF SOUTHERN EARLY TYPE GALAXIES**
A. C. Danks and M. R. Perez (Computer Sciences Corp., Greenbelt, MD.) *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 587-590 (For primary document see N91-17861 09-90)
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Observations from an in progress program to study early type galaxies are presented. International Ultraviolet Explorer (IUE) spectra of the southern galaxies NGC 1326 and 1808 are presented and compared to IUE archival spectra of four galaxies of approximately similar morphological type. The targets were selected on the basis of their infrared astronomy satellite emission, peculiarities in their dust structure as revealed from charge coupled device frames and the presence of H I from 21 cm data. Preliminary results show large differences in stellar populations, and the presence of early spectral type stars are correlated with UV extinction and IR excess. Interpretation of the data is presented, discussing the correlations between extinction, gas content and stellar populations. ESA

**N91-17978#** Illinois Univ., Urbana. Dept. of Physics and Astronomy.
**IUE OBSERVATIONS OF INTERACTING STARBURST GALAXIES**
Susan A. Lamb, Howard A. Bushouse (Northwestern Univ., Evanston, IL.), and John W. Towns *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 591-594 (For primary document see N91-17861 09-90)
Copyright Avail: NTIS HC/MF A25; EPD, ESTEC, Noordwijk, Netherlands, HC 80 Dutch guilders

Short wavelength International Ultraviolet Explorer (IUE) spectra of Arp 248b and UGC 8315N are combined with optical spectra and interpreted using combinations of spectrum synthesis and spectral diagnostics to place constraints on a massive star population of the central regions of these galaxies and to deduce information about the star formation histories in the last 100 million years. It is found that both galaxies have substantial fractions of their optical light coming from massive stars and that the UV flux from Arp 248b may have a sizeable contribution from WR stars. The UV spectra are dominated by radiation from evolved massive stars and an age is given to the burst in Arp 248b of a few tens of million of years. ESA

**N91-17979*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
**SCIENCE OBSERVATIONS WITH THE IUE USING THE ONE-GYRO MODE**
C. Imhoff, R. Pitts, R. Arquilla, Chris R. Shrader, M. R. Perez, and J. Webb *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 595-596 Prepared in cooperation with Computer Sciences Corp., Lanham, MD (For primary document see N91-17861 09-90)
(Contract NAS5-29375)
Copyright Avail: NTIS HC/MF A25; EPD, ESTEC, Noordwijk, Netherlands, HC 80 Dutch guilders CSCL 03B

The International Ultraviolet Explorer (IUE) attitude control system originally included an inertial reference package containing six gyroscopes for three axis stabilization. The science instrument includes a prime and redundant Field Error Sensor (FES) camera for target acquisition and offset guiding. Since launch, four of the six gyroscopes have failed. The current attitude control system utilizes the remaining two gyros and a Fine Sun Sensor (FSS) for three axis stabilization. When the next gyro fails, a new attitude control system will be uplinked which will rely on the remaining gyro and the FSS for general three axis stabilization. In addition to the FSS, the FES cameras will be required to assist in maintaining fine attitude control during target acquisition. This has required thoroughly determining the characteristics of the FES cameras and the spectrograph aperture plate as well as devising new target acquisition procedures. The results of this work are presented. ESA

**N91-17980#** Observatoire de Strasbourg (France).
**CLASSIFICATION OF IUE LOW-DISPERSION STELLAR SPECTRA**
A. Imadache and M. Creze *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 597-600 (For primary document see N91-17861 09-90)
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As part of the current UV stellar spectra classification program, an automated classification technique adapted to the International Ultraviolet Explorer (IUE) dispersion spectra included in the Uniform Low Dispersion Archive (ULDA) database is developed. The method is based on multivariate data analyses and does not assume any a priori spectral knowledge. The classification tool being developed should be able to survey periodically a spectral archive and to point out any abnormal object that would possibly remain undetected in the case of a nonsystematic approach. ESA

**N91-17981#** Observatoire de Strasbourg (France). Centre des Donnees Astronomiques de Strasbourg.
**HOMOGENIZING THE OBJECT NOMENCLATURE IN THE IUE LOG OF OBSERVATIONS**
G. Jasniewicz, D. Egret, Michael Barylak, and Willem Wamsteker (European Space Agency. ESA Tracking Station, Madrid, Spain ) *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 601-603 (For primary document see N91-17861 09-90)
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For the International Ultraviolet Explorer (IUE) project, the homogenization of object identifications and coordinates in the merged log of IUE observations was undertaken. A unique homogeneous identifier is produced for each entry in the log, using the SIMBAD database as a reference, and thus allowing solution of redundancies. During this process, a number of ambiguous or erroneous identifications or coordinates are discovered and corrected. The result is incorporated in the next versions of the merged log, and of the Uniform Low Dispersion Archive. Various aspects of the homogenization project are described. ESA

**N91-17982#** Lund Observatory (Sweden).
**ENHANCING IUE SPECTROPHOTOMETRY: A CASE STUDY OF BETA HYDRI**
Peter Linde and Dainis Dravins *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 605-608 (For primary document see N91-17861 09-90)
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New algorithms for improved International Ultraviolet Explorer (IUE) spectral image processing are presented. Geometric image displacement is handled by actual measurements in the flat field calibration images and in each exposed image. Using improved remapping algorithms, the geometric correction and photometric calibration can then be performed in a way that removes most of the so called fixed pattern. In a project for studying the chromospheric activity of solar type star Beta Hydri, about 100 exposures are obtained and analyzed with the algorithms. A comparison with standard software shows a notable improvement in a signal to noise ratio. This allows a significantly more detailed astrophysical evaluation of the available data. The technique has been adopted by the IUE project in its planned reprocessing of the entire IUE archive. ESA

**N91-17983#** Rutherford Appleton Lab., Chilton (England).
**THE USSP/ULDA PROJECT**
J. Murray, C. Driessen, and A. Talavera (European Space Agency. ESA Tracking Station, Madrid, Spain ) *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 609-610 (For primary document see N91-17861 09-90)
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The International Ultraviolet Explorer (IUE) Uniform Low Dispersion Archive (ULDA) and the accompanying ULDA Software Support Package (USSP) are described. The data and software have been installed in 17 countries worldwide and in excess of 47,000 spectra have been extracted from the archive. The progress of the package is reviewed and its performance compared with that the other IUE data retrieval systems. ESA

**N91-17984#** European Southern Observatory, Garching (Germany, F.R.). Space Telescope-European Coordinating Facility.
**DEARCHIVING IUE LBL IMAGES FROM OPTICAL DISK** **c82**
Fabio Pasian, Michael Barylak, and Piero Benvenuti (European Space Agency, Paris, France ) *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 611-612 (For primary document see N91-17861 09-90)
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The Line By Line (LBL) archive is composed of the International Ultraviolet Explorer (IUE) low resolution LBL image data, stored in FITS format on optical disks. The LBL archive consists of 22,524 files, totalling approximately 9 Gbytes on ten optical disk sides. Dearchiving exercises carried out to test the efficiency in servicing user requests for LBL data are described. Dearchived data was stored on magnetic tapes, 8 mm cartridges or transferred via network. The results prove to be extremely satisfactory, showing that even large requests (in the order of 300 images) can be efficiently processed in a couple of hours. ESA

**N91-17985*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
**NSSDC: PRESERVING TIME WITH TECHNOLOGICAL ADVANCES** **c82**
Charleen Perry *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 613-615 (For primary document see N91-17861 09-90)
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The National Space Science Data Center (NSSDC) has always striven to use the best methods and media currently available from data accessibility and archive management. The various advantages and disadvantages of four different media forms that have been used by NSSDC over 12 years of archiving and distributing of International Ultraviolet Explorer (IUE) data are

discussed. The four media are nine track magnetic tape, IBM 3850 mass storage, Memorex 3480 18 track tape catridge, and the Sony 6.5 Gbyte Century optical disk. The CD-ROM medium is also discussed. ESA

**N91-17986*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
**AN ACCURATE REGISTRATION TECHNIQUE FOR DISTORTED IMAGES c82**
Michele DeLaPena, Richard A. Shaw, Peter Linde, and Dainis Dravins (Lund Observatory, Sweden ) *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 617-619 (For primary document see N91-17861 09-90)
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Accurate registration of International Ultraviolet Explorer (IUE) images is crucial because the variability of the geometrical distortions that are introduced by the SEC-Vidicon cameras ensures that raw science images are never perfectly aligned with the Intensity Transfer Functions (ITFs) (i.e., graded floodlamp exposures that are used to linearize and normalize the camera response). A technique for precisely registering IUE images which uses a cross correlation of the fixed pattern that exists in all raw IUE images is described. ESA

**N91-17987*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
**A NEW PHOTOMETRIC CORRECTION TECHNIQUE FOR THE IUE FINAL ARCHIVE c82**
Richard A. Shaw (Computer Sciences Corp., Lanham, MD.) *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 621-622 (For primary document see N91-17861 09-90)
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A substantial fraction of the noise in reduced International Ultraviolet Explorer data is shown to result from limitations of the image processing methods used. An improved method for photometrically correcting spectral images that will be used in the IUE final archive processing software is described. An image processed with this photometric correction software is shown to have not only lower noise overall, but none of the periodic changes in noise amplitude. The improvement that is realized through the approach not only solves a long standing difficulty with IUE data reduction techniques, but substantially enhances the quality of the IUE archive. ESA

**N91-17988#** Computer Sciences Corp., Lanham, MD. Science Programs.
**THE ARCHIVAL REPROCESSING OF IUE DATA. 3: RESULTS OF THE NEW PROCESSING METHOD FOR IUE DATA c82**
Joy Y. Nichols-Bohlin, Michele DeLaPena, and Richard A. Shaw *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 623-626 (For primary document see N91-17861 09-90)
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A method of image processing, including photometric correction of the data and spectral extraction, developed by the NASA International Ultraviolet Explorer (IUE) project in anticipation of a final, archival reprocessing of all IUE spectral data is described. Test results from a prototype of this new processing method are presented which quantify the improvement in the signal to noise ratio of the data. A variety of images from the IUE archives are selected for these tests, including low and high dispersion data, underexposed and optimally exposed data, images with high background levels due to radiation or sky flux, and trailed, point and extended source spectra. While some improvements are yet to come, significant increases in the signal to noise ratio are already apparent on the test processed data, ranging from 10 to 50 percent. ESA

**N91-17989*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
**A REVISED PARAMETRIZATION OF THE DISPERSION CONSTANTS FOR HIGH DISPERSION IUE IMAGES c82**
Myron A. Smith (Computer Sciences Corp., Lanham, MD.) *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 627-629 (For primary document see N91-17861 09-90)
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An economical system of parameterizing dispersion constants spectra is derived and applied to International Ultraviolet Explorer (IUE) spectra by equating specific terms to geometric coordinates of an echellogram. Because of the virtual property of the IUE camera pixels, several geometrical rectifications can be performed analytically before the dispersion relations are solved for line and sample position. This permits the relations to be decoupled and reduced to two terms apiece, the simplest representation possible. A generalization of these principles allows the dispersion relations to be determined neatly in other echelle systems having certain well understood distortions. Prismatic cross dispersion, S wave distortion, and optical aberrations are some areas in which this system can be used. ESA

**N91-17990*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
**A NEW APPROACH TO REMOVE INTERORDER BACKGROUND IN HIGH DISPERSION IUE IMAGES c82**
Myron A. Smith (Computer Sciences Corp., Lanham, MD.) *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 631-633 (For primary document see N91-17861 09-90)
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A two dimensional Chebyshev interpolating scheme, followed by modeling of point spread functions as Voigt profiles, is proposed for final archiving IUESIPS to remove the interorder overlap from the smoothed background fluxes of high dispersion International Ultraviolet Explorer (IUE) images. Tests of the first and last stages of the algorithm suggest that it can give a considerably better zero point than the old IUESIPS algorithm which samples local interorder background. ESA

**N91-17991*#** San Diego State Univ., CA. Dept. of Electrical and Computer Engineering.
**PHOTOABSORPTION AND PHOTODISSOCIATION OF MOLECULES IMPORTANT IN THE INTERSTELLAR MEDIUM**
**Annual Report, 15 Jan. 1990 - 14 Jan. 1991**
Long C. Lee and Masako Suto 22 Feb. 1991 391 p
(Grant NAGw-319)
(NASA-CR-187944; NAS 1.26:187944) Avail: NTIS HC/MF A17 CSCL 03B

The photoabsorption, photodissociation, and fluorescence cross sections of interstellar molecules are measured at 90 to 250 nm. These quantitative optical data are needed for the understanding of the formation and destruction processes of molecules under the intense interstellar UV radiation field. Research covering the following topics is presented: (1) fluorescences from photoexcitation of CH4, CH3OH, and CH3SH; (2) NO gamma emission from photoexcitation of NO; (3) photoexcitation cross sections of aromatic molecules; (4) IR emission from UV excitation of HONO2; (5) IR emission from UV excitation of benzene and methyl-derivitives; and (6) IR emission from UV excitation of polycyclic aromatic hydrocarbon molecules. K.S.

# 91 LUNAR AND PLANETARY EXPLORATION

Includes planetology; and manned and unmanned flights.

For spacecraft design or space stations see *18 Spacecraft Design, Testing and Performance.*

**N91-17992** New Mexico State Univ., Las Cruces.
**SATURN'S SEASONAL WINDS AND TEMPERATURE: THE EFFECT OF THE RING SYSTEM ON THE TROPOSPHERE AND STRATOSPHERE Ph.D. Thesis**
Christopher Dwight Barnet 1990 396 p
Avail: Univ. Microfilms Order No. DA9029733

The radiative properties of Saturn's rings (insolation shadowing, insolation scattering, and thermal emission) were incorporated into a seasonal, zonally-averaged, radiative-dynamical model to investigate the magnitude of small seasonal fluctuations in the troposphere and stratosphere of Saturn. Although the radiative time constant is large in Saturn's troposphere and stratosphere, the rings induce significant latitudinal insolation gradients resulting in potential disturbances in the upper stratosphere. The results of the model are compared to the Pioneer and Voyager Radio Sub-System (RSS) vertical temperature profile measurements and to the Voyager Infrared Interferometric Spectrometer (IRIS) latitudinal temperature profile measurements. In the upper stratosphere (1 to 30 mBar) the heating is dominated by methane and the model can be directly compared to the Voyager data. Below the temperature minimum the radiative time constant is sufficiently long to strongly dampen seasonal variations, however, the temperature excursions seen in the IRIS data are significantly larger than those predicted by the radiative model. The thermal effects of the strong Saturnian zonal winds are simulated with a first-order dynamical model to provide some insight into the lower boundary conditions. The remaining differences between the model and the Voyager IRIS data-sets are used to estimate the quantity of aerosol required near the tropopause region. The magnitudes of the wind and temperature perturbations, caused by the radiative effects of Saturn's rings, are discussed in the context of the future Hubble Space Telescope and the planned Cassini Saturnian Orbiter missions. Dissert. Abstr.

**N91-17993*#** San Francisco State Univ., CA. Dept. of Chemistry and Biochemistry.
**THE SPECTROSCOPIC, CHEMICAL, AND PHOTOPHYSICAL PROPERTIES OF MARTIAN SOILS AND THEIR ANALOGS (MERC, PHASE 2) Final Report**
Amos Banin and James Orenberg 1990 28 p
(Contract NCC2-352)
(NASA-CR-187898; NAS 1.26:187898) Avail: NTIS HC/MF A03
CSCL 03B

A series of variably proportioned iron/calcium smectite clays and iron loaded smectite clays containing iron up to the level found in the Martian soil were prepared from a typical montomorillonite clay using the Banin method. Evidence was obtained which supports the premise that these materials provide a unique and appropriate model soil system for the Martian surface in that they are consistent with the constraints imposed by the Viking surface elemental analysis, the reflectance data obtained by various spacecraft instruments and ground based telescopes, and the chemical reactivity measured by one of the Viking biology experiments, the Labeled Release (LR) experiment. Author

# 92 SOLAR PHYSICS

Includes solar activity, solar flares, solar radiation and sunspots.

For related information see *93 Space Radiation.*

**N91-17994#** National Geophysical Data Center, Boulder, CO.
**SOLAR-GEOPHYSICAL DATA NUMBER 552, AUGUST 1990. PART 1: (PROMPT REPORTS) DATA FOR JULY, JUNE, 1990 AND LATE DATA**
H. E. Coffey Aug. 1990 146 p
(PB91-103705; SGD-552-PT-1) Avail: NTIS HC/MF A07
CSCL 03B

The following subject areas are covered: Detailed index for 1989-1990; data for July 1990 - solar-terrestrial environment, IUWDS alert periods (advance and worldwide), solar activity indices, solar flares, solar radio emission, Stanford mean solar magnetic field; data for June 1990 - solar active regions, sudden ionospheric disturbances, solar radio spectral observations, cosmic ray measurements by neutron monitor, geomagnetic indices; late data - solar radio spectral observations, Wiessenau March 1990, cosmic ray measurements by neutron monitor, Huancayo April-May 1990. Author

**N91-17995#** National Geophysical Data Center, Boulder, CO.
**SOLAR-GEOPHYSICAL DATA NUMBER 552, AUGUST 1990. PART 2: (COMPREHENSIVE REPORTS) DATA FOR FEBRUARY 1990 AND MISCELLANEOUS**
H. E. Coffey Aug. 1990 81 p
(PB91-103713; SGD-552-PT-2) Avail: NTIS HC/MF A05
CSCL 03B

The main subject areas covered are: detailed index for 1989-1990; data for February 1990 - solar flares, solar radio bursts at fixed frequencies; interplanetary solar particles and plasma, solar x ray radiation from GOES satellite, mass ejections from the sun, active prominence and filaments. Author

**N91-17996#** National Center for Atmospheric Research, Boulder, CO. High Altitude Observatory.
**A CATALOGUE OF MASS EJECTIONS OBSERVED BY THE SOLAR MAXIMUM MISSION CORONAGRAPH**
O. C. St.Cyr and J. T. Burkepile Jul. 1990 123 p Sponsored by NSF, Washington, DC
(PB90-265166; NCAR/TN-352+STR) Avail: NTIS HC/MF A06
CSCL 03B

A catalog of coronal mass ejections identified in data from the High Altitude Observatory's coronagraph aboard NASA's Solar Maximum Mission Spacecraft is provided. The list includes events observed during 1980 and between 1984 and 1989. The authors anticipate that many other investigators, including members of other SMM teams, groundbased solar observers, and interplanetary researchers will find this list useful. GRA

**N91-17915#** Lund Observatory (Sweden).
**THE DISTANT FUTURE OF SOLAR ACTIVITY: A CASE STUDY OF BETA HYDRI**
Dainis Dravins, Peter Linde, T. R. Ayres, K. Fredga, G. Gahm, L. Lindegren, J. L. Linsky, B. Monsignori-Fossi, A. Nordlund, and T. Simon (Hawaii Univ., Honolulu.) et al *In* ESA, Evolution in Astrophysics: IUE Astronomy in the Era of New Space Missions Aug. 1990 p 323 (For primary document see N91-17861 09-90)
Copyright Avail: NTIS HC/MF A25; EPD, ESTEC, Noordwijk, Netherlands, HC 80 Dutch guilders

# 93 SPACE RADIATION

Includes cosmic radiation; and inner and outer earth's radiation belts.

For biological effects of radiation see *52 Aerospace Medicine.* For theory see *73 Nuclear and High-Energy Physics.*

**N91-17997*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
**PRELIMINARY CALCULATION OF SOLAR COSMIC RAY DOSE TO THE FEMALE BREAST IN SPACE MISSION**
Mark Shavers, John W. Poston, William Atwell, Alva C. Hardy (National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.), and John W. Wilson Washington Feb. 1991 8 p

(NASA-TM-4235; L-16833; NAS 1.15:4235) Avail: NTIS HC/MF A02 CSCL 03B

No regulatory dose limits are specifically assigned for the radiation exposure of female breasts during manned space flight. However, the relatively high radiosensitivity of the glandular tissue of the breasts and its potential exposure to solar flare protons on short- and long-term missions mandate a priori estimation of the associated risks. A model for estimating exposure within the breast is developed for use in future NASA missions. The female breast and torso geometry is represented by a simple interim model. A recently developed proton dose-buildup procedure is used for estimating doses. The model considers geomagnetic shielding, magnetic-storm conditions, spacecraft shielding, and body self-shielding. Inputs to the model include proton energy spectra, spacecraft orbital parameters, STS orbiter-shielding distribution at a given position, and a single parameter allowing for variation in breast size. Author

**N91-17998*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

**PRELIMINARY ANALYSIS OF A RADIOBIOLOGICAL EXPERIMENT FOR LIFESAT**

John W. Wilson, Lawrence W. Townsend, John E. Nealy, Alva C. Hardy, William Atwell, and Walter Schimmerling (National Aeronautics and Space Administration, Washington, DC.) Washington Feb. 1991 10 p

(NASA-TM-4236; L-16844; NAS 1.15:4236) Avail: NTIS HC/MF A02 CSCL 03B

With the possibility of performing radiation life science experiments on a dedicated satellite (LifeSat) in space, a combined effort in radiation physics and radiation dosimetry, in addition to radiation biology, is clearly required to ensure that meaningful biological experiments can be performed. To better understand the relationship of these disciplines, some possible LifeSat missions are examined. As a trial biological system, tumorigenesis is considered in the Harderian gland of mice, a system of sufficient radiosensitivity for which relative biological effectiveness (RBE) is well defined by laboratory experiments. Author

**N91-17999*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

**RADIATION PROTECTION FOR HUMAN MISSIONS TO THE MOON AND MARS**

Lisa C. Simonsen and John E. Nealy Washington Feb. 1991 27 p

(NASA-TP-3079; L-16892; NAS 1.60:3079) Avail: NTIS HC/MF A03 CSCL 03B

Radiation protection assessments are performed for advanced Lunar and Mars manned missions. The Langley cosmic ray transport code and the nucleon transport code are used to quantify the transport and attenuation of galactic cosmic rays and solar proton flares through various shielding media. Galactic cosmic radiation at solar maximum and minimum, as well as various flare scenarios are considered. Propagation data for water, aluminum, liquid hydrogen, lithium hydride, lead, and lunar and Martian regolith (soil) are included. Shield thickness and shield mass estimates required to maintain incurred doses below 30 day and annual limits (as set for Space Station Freedom and used as a guide for space exploration) are determined for simple geometry transfer vehicles. On the surface of Mars, dose estimates are presented for crews with their only protection being the carbon dioxide atmosphere and for crews protected by shielding provided by Martian regolith for a candidate habitat. Author

**N91-18000#** Lawrence Livermore National Lab., CA. Physics Dept.

**RESONANT COMPTON SCATTERING IN MODELS OF GAMMA-RAY BURST SOURCES. PART 1: THEORY**

Charles D. Dermer (California Univ., Berkeley.) and Peter Vitello 1990 10 p Presented at the Los Alamos Workshop on Gamma-Ray Bursts, Taos, NM, 29 Jul. - 3 Aug. 1990

(Contract W-7405-eng-48)

(DE91-005267; UCRL-JC-105323-PT-1; CONF-9007101-3-PT-1) Avail: NTIS HC/MF A02

A simplified treatment of the physics involved when soft photons are Compton-scattered by relativistic electrons beamed along the direction of a strong magnetic field is given. The following results are obtained through elementary considerations: If the steady-state electron distribution function is described by a power-law spectrum with index p, then the spectral index alpha of the Compton-scattered photon number spectrum breaks from alpha is congruent to 0 to alpha is congruent to p + 2 at the dimensionless scattered photon energy epsilon(sub s) is equivalent to hv(sub s)/m(sub e)c squared is approximate to 2 epsilon(sub B) squared/epsilon, where epsilon(sub B) and epsilon are the dimensionless cyclotron and soft photon energies, respectively; the characteristic beaming angle theta(sub s) of photons scattered to high energies goes roughly as theta(sub s) is approximately epsilon(sub B)/epsilon(sub s); if electrons have Lorentz factor gamma is approximate to or greater than epsilon(sub B)/epsilon, then the resonant Compton-scattering electron energy-loss rate is the absolute value of d(gamma)/dt is proportional to 1/gamma; the scattered photon spectrum produced when monoenergetic electrons cool by scattering soft photons has spectral index alpha is congruent to 1; if electrons are injected in the shape of power law with injection spectral index Gamma, then the resonant-scattered cooling spectrum has spectral index alpha is congruent to Gamma. Resonant Compton-scattered photon spectra, similar to observed gamma-ray burst spectra, result from the injection of a power-law distribution of electrons with a low-energy cutoff into a thick target of soft photons. This model can satisfy the x ray paucity constraint, as well as constraints imposed by gamma - B and gamma - gamma photon attenuation for MeV photons produced very close to the surface of neutron stars with teragauss fields at kiloparsec distances. DOE

**N91-18001#** Argonne National Lab., IL.

**BELIEVABILITY OF SIGNALS FROM COSMIC RAY SOURCES**

Maury Goodman Nov. 1990 6 p Presented at the International Conference on High Energy Gamma Ray Astronomy, Ann Arbor, MI, 2-5 Oct. 1990

(Contract W-31-109-eng-38)

(DE91-006489; ANL-HEP-CP-90-118; CONF-9010289-4) Avail: NTIS HC/MF A02

This paper discusses some of the criteria by which an observer judges whether to believe a signal or limit what has been reported for a cosmic ray source. The importance of specifying the test before looking at the data is emphasized. DOE

**N91-18002#** Los Alamos National Lab., NM.

**SEARCH FOR UHE EMISSION FROM 4U0115+63**

D. E. Alexandreas, R. C. Allen, S. D. Biller, G. M. Dion, X-Q. Lu, P. R. Vishwanath, G. B. Yodh, D. Berley, C. Y. Chang, and B. L. Dingus (Maryland Univ., College Park.) et al 1990 6 p Presented at the International Conference on High Energy Gamma Ray Astronomy, Ann Arbor, MI, 2-5 Oct. 1990 Sponsored in part by NSF and California Univ, San Diego, La Jolla

(Contract W-7405-eng-36)

(DE91-005926; LA-UR-90-4437; CONF-9010289-3) Avail: NTIS HC/MF A02

We report here the preliminary results of our observations of the sporadic x ray binary system 4U0115 + 63. The CYGNUS air shower array has been collecting data since April 1986. No significant excess is seen from the direction of this source, nor any correlation with its 24-day orbital period. A 90 percent confidence-level upper limit on the flux from 4U0115 + 63 is 2.8 times 10(exp -13) cm(sup -2) s (sup -1) above 50 TeV. This flux limit is considerably lower than those reported by other UHE experiments. Search for periodicity at the neutron star frequency is in progress. DOE

# 99 GENERAL

**N91-18003*#** National Aeronautics and Space Administration, Washington, DC.
**NASA HIGHLIGHTS, 1986 - 1988**
1990 19 p Original contains color illustrations
(NASA-PAM-250; NAS 1.75:250) Avail: NTIS HC/MF A03; 16 functional color pages CSCL 05A

Highlights of NASA research from 1986 to 1988 are discussed. Topics covered include Space Shuttle flights, understanding the Universe and its origins, understanding the Earth and its environment, air and space transportation, using space to make America more competitive, using space technology an Earth, strengthening America's education in science and technology, the space station, and human exploration of the solar system.

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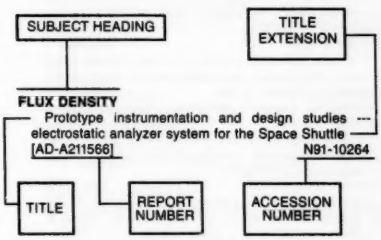


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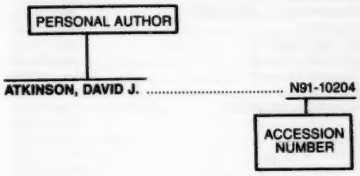


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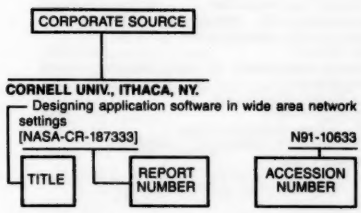


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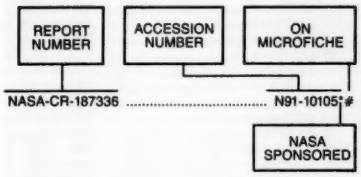


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